(ESTABLISHED 1832.)

AMERICAN ENGINEER

CAR BUILDER AND RAILROAD JOURNAL.

R. M. VAN ARSDALE, Proprietor. **G. M. BASFORD, Editor.**

Published Monthly at 140 Nassau Street, New York.

INDEX TO VOLUME LXXI.—1897.

(The asterisk indicates that the article is illustrated.)

43378

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

JANUARY, 1897.

CONTENTS.

THE ALTOONA SHOPS OF THE PENNSYLVANIA RAILROAD.

VII.

(*Continued from page 320, Vol. LXX.*)

The reader of these articles has learned before he has reached this one that no systematic arrangement of them or the subject they embrace has been aimed at. They have merely been somewhat full reports made from notes of personal observation and investigation. No introductory remarks are therefore needed for the following description of

VULCANIZED GRAPHITE BEARINGS.

One of the novelties in the shops is the use of this material in the bearings of connecting-rods and in engine-truck boxes. Vulcanized graphite is substantially what is known as vulcanized fiber impregnated with powdered graphite or plumbago. In applying it to bearings, a groove is planed in the brass longitudinally to the journal. Thus in the bearings for a journal $5\frac{1}{4}$ inches diameter, two grooves each 1 inch wide and $\frac{3}{8}$ inch deep, were slotted transversely in the bearing and longitudinally to the axis of the journal. These are made slightly dove-tailed so as to hold the fiber in position. It is made in sheets $\frac{1}{8}$ inch thick, and it is found that it wears better if the pieces put into the journal are placed so that the wear will come endwise to the material or on its edge as it is made. Two thicknesses of it are therefore drawn into each groove from its end. The report is that it wears much better than babbitt, and is in every way more satisfactory.

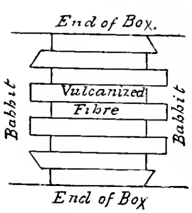


Fig. 1.

For truck boxes the fiber is cut into strips 2 inches long by $1\frac{1}{2}$ inches wide and $\frac{1}{4}$ inch thick. These are placed as shown in Fig. 1, which is an inverted plan of the bearing. Babbitt is then cast in the box so as to fill the space on each side of the fiber and conform to the journal. A box was shown which had been so hot as to melt the babbitt, but the fiber was still intact. Very excellent reports are given of the working of this material. It is made by the Vulcanized Fiber Company of Wilmington, Del.

KINDLING LOCOMOTIVE FIRES WITH OIL.

In the engine-houses at Altoona the oil fire-kindling apparatus and process is generally used for lighting the fires in locomotives. The apparatus consists of a portable cylindrical tank or reservoir, which holds a gallon and a half of crude oil. A force pump is attached to the inside of this, and a rubber hose with a flat nozzle is connected to it. The nozzle is made of a piece of $\frac{1}{2}$-inch gas pipe a few feet long, with its end flattened to form the nozzle. Before kindling the fire a layer of coal about 3 inches thick is spread over the grate and a few bunches of greasy waste is laid on top. The oil is then sprayed over the surface of the coal by the force pump attached to the reservoir, and the waste is then lighted. The engine-houses are now provided with steam pipes which run all around the outside, and from which branches lead down to an underground connection alongside of the engine pits. The blower pipes on the locomotives also have a screw connection on the outside of the smoke boxes. A hose is connected to the steam pipe underground, and to the blower pipe. After the waste and oil have been burning for about ten minutes steam is turned on to the blower, which of course acts on the fire so as to raise steam in from 50 to 60 minutes. In urgent cases sufficient steam has been raised to run an engine out of the house and on to the turn-table in 28 minutes; but it is not considered advisable to do it so quickly. The steam pipes have a connection leading into the pits, so that any accumulation of water in them can be blown out before steam is turned on to the blower.

CLEANING FLUES WITH COMPRESSED AIR.

Among the many uses to which compressed air is applied in these shops is that of cleaning flues. To do this a piece of $\frac{3}{8}$-inch gas pipe about 10 feet long is used, which is attached to a rubber hose with a stop-cock between them to turn on and shut off the the air. If, when the flues are cleaned, the engine has steam on, the rubber hose is attached by an ordinary brake coupling to the brake pipes in the tender. The airbrake pump is then started which furnishes the supply of compressed air which is needed. The gas pipe is inserted through the furnace-door and the current of compressed air quickly removes the soot and ashes inside of them. It is thought that if a piece of pipe long enough to reach nearly to the front ends of the tubes is used that they are cleaned more thoroughly than they are with one which will extend only a short distance into them. To handle so long a pipe, however, it is necessary to disconnect the engine from the tender, which consumes time and labor, and therefore the shorter pipe is employed.

CARE OF ENGINE LANTERNS, ETC.

A very considerable expense was formerly incurred on this road in supplying engines with red and white lanterns, torches, oil-cans, monkey-wrenches, etc. These would be broken, or lost, or destroyed. The plan was, therefore, adopted in the engine-houses at Altoona of supplying each engineer with these equipments and holding him individually responsible for them. With this object in view a room and attendant was provided for storing and checking these articles; and whenever a man has completed his run he is required to check them in this depository. He alone, therefore, becomes responsible for them, and if they are injured or lost he can be called to account and any undue carelessness or neglect is counted against him. The result of the introduction of this system was a greatly reduced cost for such supplies.

NEW BLACKSMITH SHOP.

One of the new, or, it might be said, the only extension of the shops in Altoona, which has been made recently is a new smith shop, which has just been occupied. It is 223 feet 8 inches by 68 feet and 20 feet high to the roof truss. It has 25 forges, a number of heating furnaces for bolts and similar work, two shears and punches, three bolt machines and a "bulldozer." The equipment is not yet all in the shop, but, when completed, it will form an important addition to this great establishment.

CAR SHOPS.

The general arrangement of the car shops of the Pennsylvania Railroad at Altoona is shown in the plan which was published in our June number. They are located along the main line of the railroad, which runs in an easterly and westerly direction through the city of Altoona, part of which is on the north and part on the south side of the railroad. For the convenience and safety of foot passengers a foot bridge has been built across the railroad and extending over the grounds occupied by the car shops. The view, which was also published in the June number, was taken from the bridge, and gives an idea of the appearance of the buildings and grounds, but even the faithfulness of photography does not show the scrupulous "good order" in which the buildings and their surroundings are kept. Many of the parts of cars when completed are piled outside of the shops, and the care and regularity in which they are arranged can be compared only to that which military men practice in arranging shot, guns and stores in arsenals and fortresses.

The grounds of the shops here described are kept clean and orderly and in the west end, when it was practicable, there was an example of landscape gardening of no mean pretensions and of very pleasing appearance. To show how far the spirit and practice of order is carried, in entering near the office the visitor may notice several cars for the reception of various waste products. One of them is for turnings, which was divided into three compartments, each lettered distinctly one for iron turnings, another cast-iron borings and a third steel turnings, the purpose being to keep all them separate and thus increase their value either for sale or re-use.

The first shop visited was the freight, repair and erecting shop, which is an enormous round-house 433½ feet in diameter outside, having an open space inside with a 100-foot turn-table in the center. There are thirty-eight tracks or stalls with pits between the rails, each track of sufficient length to be occupied by two cars under construction or repair. There has been much criticism of the adaptation of this plan of shop for the purpose for which it is used. On inquiry of the foreman, Mr. Andrew Kipple, he reports that his experience leads him to approve of the plan for a car-repair or erecting shop, that it facilitates the handling of the cars by a switching engine and the turn-table which is operated by steam power, and that the radial position of the tracks on which the work is done gives ample room on the outer portion of the building, where the tracks diverge, for work benches, the temporary storage of material, etc.

In these shops, as in all the others at Altoona, the system of piece work is generally adopted, which was described in our December number.

Comparatively little new work is in progress in any of the departments of the car works. An order for 75 refrigerator cars for carrying dairy products was being executed at the time of our visit. These are 36 feet long over the bodies, have Janney couplers and air-brakes. The sides are filled with heavy hair felt, covered with two layers of brown paper. Three furniture cars are also in progress, which have very large bodies to give as much storage-room as possible.

All the heavy parts of the cars are stored out of doors, but the space occupied by two tracks is devoted to the smaller parts, and those which would be injured by the weather. The material for each job is selected and loaded on cars or trucks run on the turntable and then delivered to the track on which the job for which the material is intended is in progress.

Some idea of the amount of the car-repair work done in Altoona may be formed when it is said that at the present dull times about 300 cars are repaired daily. Those needing only slight repairs are overhauled in the new yards east of the car works, which is a sort of immense temporary hospital for invalid rolling stock.

TRUCK SHOPS.

A shop which, compared with some of the others is small, being only 85 by 87 feet, is devoted exclusively to the assembling and erection of car trucks. The building is isolated, and is thus admirably lighted on all sides. The axles used here are turned and the wheels are bored in another shop. Most of the other machine work is, however, done in the building here described. The standard freight truck used by the Pennsylvania Railroad is of the "diamond" pattern with channel-bar transoms. The holes in the arch bars for the truck sides, are drilled by two multiple drills each with eight spindles and another double drill bores the holes in the spring seats. A somewhat unusual machine, built by Wm. Sellers & Co., is used for drilling the flanges of the channel bars. The 18 spindles and drills of this machine work horizontally, in two rows, opposite to each other. The channel bar is placed between the two rows, with the flanges up, so that all the 18 holes in the two opposite flanges are drilled at the same time. Another vertical upright machine drills and countersinks eight holes in the web or plate of the channel bar. When the holes are all drilled the castings, etc., which are attached to each separate bar are riveted to it in a stationary hydraulic riveter. When this is to be done they are placed on two cast-iron stands made for the purpose and fastened to the floor the proper distance apart and of a certain height for doing the work. The castings and attachments which are riveted to the two bars are then put into position and riveted by a portable hydraulic machine. Four pairs of the cast-iron stands are provided, and the hydraulic riveter is carried by a traveling crane which has about 12 feet span. With this the riveter can be placed in any position over any of the four pair of stands.

A grinding machine which was new to the writer is used for grinding the cover-seats of the journal boxes. It consists of a shaft on each end of which is a cylindrical head or disc about 8 inches diameter which carries three emery "plugs." These are cylinders of emery 1½ inches diameter by 3¾ inches long. These are fastened by a sort of cam device, analogous in its action to that of a scroll chuck, and are clamped fast so as to project a short distance from the face of the disc. The journal-box is placed into a position in front of the disc which brings the cover-seat parallel to the face of the revolving disc. The box is carried in a suitable sliding head and by a feeding arrangement the seat can be brought up in contact with the emery "plugs" and can be fed crosswise or parallel to their planes of revolution. By this means the seats are quickly ground to a true surface. Pressed-steel box covers are used. A Sellers tool grinder, a double spindle drill, several drill presses and other ordinary tools complete the equipment. Wooden bolsters are used in the trucks here described. These bolsters rest on two nests, each of four coils of spiral springs, 5 inches in diameter and made of 1-inch round steel. The seats and caps of the nests are made of pressed steel.

The trucks are assembled on a track which runs through the middle of the shop, the rails being elevated somewhat above the floor so as to bring the parts to a more convenient height for the workmen. Twelve men will put together 40 trucks in 10 hours.

PASSENGER-CAR SHOP.

The passenger-car erecting shop has five tracks parallel to each other with room for three cars on each. One of these is used for bringing in the material. At present the only new work in progress is an order for 19 new coaches; seven of these are to have vestibules. These are of a new design, the object of which was to reduce the weight of the car as much as possible, without any reduction in strength. It is expected that they will weigh 7,000 pounds less than the standard passenger cars now in use. The new cars are to seat 64 or 66 passengers. Some of them are to have stoves as an auxiliary means of heating, and these will seat only 64 passengers. All of them are to be equipped with steam heating appliances. The length of body is 54 feet and its width 9 feet 8¾ inches over frames. The outside and center sills are 5 by 8 inches, and the intermediate 4½ by 7½ inches. The platforms have been designed especially with reference to strength, and they are equipped with Buhoup's three-stem coupler, with a Janney head. The platforms are provided with buffer-plates attached to double-stem spring buffers.

The outside of the cars instead of being paneled are sheathed with vertical strips ⅝ inches thick and 2 inches wide. A feature which has been introduced in many places is to groove the rails, truss-planks and some of the panels with a number of longitudinal

grooves. These are ⅝ inch wide by ⅝ inch deep, the bottoms being round. The truss-plank, for example, is 1¾ by 8¼ inches and grooved on the back. The top plate, instead of consisting of a single piece on top of the posts, is made of two pieces ⅞ by 9 inches attached to each side of the posts, both grooved on the inside. This arrangement leaves room so that the window sash can raise up between them. The letter-board on the outside is ⅞ by 11¼ inches, and is also grooved inside. The upper window belt rail is 1¼ by 4¼ inches. The outside window capping is made of walnut, and both are grooved. The flooring of some of the cars consists of a single longitudinal floor 1¼ inches thick. Some of the others will be made of two thicknesses, each ⅝ inch thick, the top one being of maple.

The vestibuled cars will have two water closets, but those without vestibules will have only one. Formerly the clear story rested on a longitudinal piece of oak, 4½ by 4⅝ inches. In the present cars the lower rail of the clear story is made of a piece of white pine, 5½ by 2⅝ inches. The mullions are also white pine and covered with thin oak on the inside.

The wooden truck sides are reinforced with ¼-inch steel plates on the inside. Wooden safety timbers have been abandoned and iron substituted in their place. A steel spring plank has also been used instead of a wooden one. The brakes are hung on the inside or between the wheels, instead of outside, as has been the practice heretofore. The axle journals are 4 by 8 inches. The body bolsters consist of two trusses made of bars 6 by ⅞ inch placed 36 inches apart from center to center, the two being connected together at the center to receive the center plate. The ends of the roofs which project over the platforms are rounded. The spaces between the floors are filled with mineral wool.

The window sashes are hung and fastened on the system of O. M. Edwards, of Syracuse, N. Y., which is new and apparently a great improvement on the ordinary method. As all travelers know to their discomfort. car windows seldom work satisfactorily. Recently we had occasion to criticise the window latches used on some of the cars of the Pennsylvania road, and the advisability of carrying a small "jimmy" for prying windows open on railroad journeys has also been suggested. In dry weather car windows are prone to rattle, and in wet weather they swell and resist the most strenuous efforts to open them. Most car windows, too, have not a sufficient number of stops to hold them up. The passenger must either be content to have the window closed or entirely open. Usually it cannot be held up a short distance only.

By the Edwards system the sashes are fitted loosely in the grooves in the post, and the sash is balanced by a coiled spring above it inside of the car sheathing, or more specifically, inside of the letter board. Long flat springs are attached to the window facings, and bear against the sides of the window sash. A double latch is attached to the middle of the window sill and is connected with the sash springs in such a way that when the two latches are compressed, the pressure of the sash springs is withdrawn from the sash and it is then entirely free to move. As it is somewhat overbalanced by the spiral spring, the sash raises of itself, when the latches are compressed, and is held in any position it may be in, when they are released, and the side springs then press against it. Altogether, it seems to be the most complete and convenient sash fixture that has thus far been devised.

On all of their day coaches the Pennsylvania Railroad authorities have adhered to the old-fashioned Venetian blinds for the windows. On the new cars here described curtains have been substituted for the blinds. The curtains are held in position by the fastening made by Forsyth Bros. & Company, of Chicago. The lower edge of the curtain is attached to a rod or tube with slides on each side which move in grooves in the window posts. At the middle of the rod is a double latch connected to the slides in some way, so that when the latches are compressed the slides are free to move in the grooves, and when the latches are released the slides are clamped and hold the curtain in any position in which it may be placed. The curtain rolls on a usual form of spring roller. Altogether the window and curtain fastenings are the most convenient and elegant that have thus far been put in cars. The blinds were discarded to save weight in the cars. The objection to curtains is that they soon get so much soiled as to be very objectionable. Some which the writer recently saw on a car of a New England railroad were extremely obnoxious by reason of the dirt and wear to which they were exposed. The abandonment of the more cleanly window blind is to be regretted.

Some of these cars are to be finished in hazelwood, others in oak, and still others in baywood. The bulkheads at the end of the car have each a very neatly designed and constructed brass grill which the Pennsylvania road has made a feature in the finish of its more recent cars. The ceilings are covered with straw-board which has been molded or stamped with shallow indentations approximating to a checker-board pattern, and painted what ladies would probably call a "crushed raspberry" color, with moldings dividing it into a number of medium-sized panels. The wood and the color of the ceiling with the uneven surface of the straw-board gives a very pleasing effect, with an entire absence of the gaudiness and over-ornamentation characteristic of many cars.

The clear stories of these cars are made 10 inches wider than those in the standard passenger cars. The side-lights are glazed with stamped colored glass with bas-relief figures. The seats in one of the cars are covered with a somewhat peculiar figured material the name of which we did not learn; the others, we were told, would be covered with plush. At the time of our visit the cars had not been weighed, so the saving which has been effected cannot be definitely stated.

PLANING MILL.

This building is 355 by 72 feet and is equipped with wood-working machinery for doing a large amount of work. This consists of eight planers, two band-saws, four crosscut saws, three turning machines, five rip saws, four mortising machines, six boring machines, one shaper, one universal wood worker, one molding machine, a knife sharpener, two saw grummers, a cross-cut automatic saw sharpener, another for band saws and two Sturtevant fans for carrying shavings and sawdust to the boiler room. A curious devise is used in connection with these fans. It was found in feeding the boilers with shavings that a considerable quantity was carried through the flues so quickly that they were not consumed but escaped from the chimney and thus were the cause of danger from fire. To obviate this strips of iron 2¼ inches wide—equal to the inside diameter of the tubes—and ⅛ inches thick were twisted and inserted in the tubes. This compelled the gases, sparks and unconsumed shavings to pass through the tubes in a spiral path, thus delaying their movement sufficiently to secure the complete combustion of the latter. It is also said that the evaporation and economy of the boiler to which the spiral plates have been applied has been materially improved. Six boilers of the locomotive type are used and the shop is driven by a 250 horse-power Corliss engine.

This shop, like all the others, is operated almost exclusively by the piece-work system. More than 1,000 different prices are needed to meet all the requirements of the work.

BLACKSMITH SHOP.

This building is 493 × 74 feet and has 96 forges and nine heating furnaces. It is equipped with seven steam hammers, a number 0, a number 1½ and a number 7 Hillis & Jones punches and shears. The latter will cut a cold bar of iron 4½ inches square and three punches are often used in it in a gang to punch holes 1½, 2 and 2¼ inches diameter at one time. Nine smaller punches are also often used in a gang to punch that number of holes through 1-inch bars at once. Besides these machines there are two vertical and two alligator shears, one Burdick 2-inch bolt machine, one Blakeslee's number 7 forging machine, which weighs 68,000 pounds, five belt hammers, two Blakeslee number 5 "bulldozers" and one Pratt & Whitney drop hammer. The power for driving the shop is provided by a 70 horse-power horizontal slide-valve engine at one end of the shop and a vertical engine at the other.

The interesting feature in this shop, which it would take a great deal more time and space to describe than can now be given to it, is the various kinds of dies, bending appliances and tools of vari-

ous kinds which have been devised for doing the great variety of work which is now used on cars. This variety has been greatly increased by the introduction of automatic couplers, air-brakes, spring-buffers and steam heating, and many of the parts now used for these appliances are of much greater complexity than those which were employed in the earlier days of railroading. This and the necessity of reducing the cost of manufacture has made it necessary to devise a great variety of appliances for doing work. The system of piece-work has also stimulated the ingenuity of the workmen to devise means which would expedite the operations they have to perform. The result is that a great variety of small tools of various kinds have been provided, which all help to diminish the cost of labor and the time required to do work. Nearly all the work is done by the piece, and the same testimony was given here as in the other shops, which was to the effect that the cost of turning out work is reduced from 50 to 75 per cent. and the output more than doubled by the piece-work system.

A very interesting book could be made if any competent person could give the time to describe and illustrate in full detail the methods and special tools and machines which are here employed. It would be impossible to explain these so that the explanation would be intelligible without elaborate illustrations, the making of which would be a formidable undertaking. One illustration of a method of saving work may be given. A brake lever is a flat bar of iron with its fulcrum nearer to one end than to the other, and tapering from the fulcrum both ways. Formerly these were drawn out to a tapered form under a hammer which required considerable time and labor. To lessen this the bars of iron are now rolled into the tapered form—a half dozen or more levers in one bar —so that all that is required is to cut them off at the right place, and of the right length, and then shear off the ends round and drill or punch the holes for the bolts. All these operations are performed almost as rapidly as the levers can be handled and counted.

Some time since an accident happened from a brakeman twisting off a brake shaft, which was badly welded, and he was thrown from a car and killed. It should be said that the brake shaft used on the Pennsylvania Railroad is about five or six feet long and 1½ inches in diameter at the lower part, a square place about the middle, 1¼ inches on a side, and the upper end is drawn out round to 1⅛ diameter. A die is now used for doing this which draws down the bar to the required size and facilitates the making of the square part without removing it from under the hammer. The shaft is thus made out of one piece and there is then no danger of breakage from a bad weld.

The iron which is intended for use in the shops is stored in racks or bins outside of the two ends of the building. Each of these bins is numbered and a card is assigned to each bin in which the iron received and that given out is entered. From this the amount on hand can be made out at any time, which should, of course, correspond with an inventory whenever it is taken. The cards are in charge of a person whose business it is to look after the stock of iron on hand, and they are stored in a case under lock and key in the engine-room.

The truck shop, which has been described, is near the blacksmith shop. When the trucks are completed, they are run out on a track alongside of the smith shop to be oiled. By the repetition of this operation, on many trucks, much oil was spilled in the ground, which thus became saturated with it. It was therefore feared that it might take fire if a piece of hot iron or a light should accidentally be applied to it. To obviate this risk, a series of sheet iron pans have been located alongside of the tracks, into which the oil drips, and from which it is readily removed.

An air hoist for loading and unloading trucks, to and from cars, is located near this place. It consists of a "gallows" frame made of wood, the top horizontal beam being trussed. A vertical air cylinder is suspended from a trolley which runs in a track on top of the horizontal beam. The cylinder has a piston and rod of the usual kind, the latter with a set of suitable hooks at its lower end to attach to a truck. Rubber hose conducts the compressed air to the cylinder. The trolley is moved transversely by means of a chain and windlass, the latter connected to one of the posts of the frame. The celerity of action of this saves much time and labor.

MACHINE SHOP.

The machine shop for doing iron work such as turning axles, boring wheels, drilling, etc., is a building 132 feet by 70 feet. It contains twelve axle lathes, four wheel-boring machines, two wheel-presses for putting on wheels and one for removing old wheels, a car-wheel grinding machine, one slotting machine, one machine for straightening axles, four lathes for miscellaneous work, one shaping machine, fifteen drill-presses, three planers and two bolt thread-cutting machines. The shop is driven by a 100-horse power compound engine. It also drives a dynamo and two Westinghouse brake pumps for compressing air for pneumatic hoists. A number of these appliances are used in the shop for handling wheels, axles, etc. The shop has capacity for turning out 100 pairs of wheels and axles per day.

One of the novelties in this shop was a burnisher for car-axle journals represented by the engraving, Fig. 2, herewith. It consists of a hardened steel cylindrical disk *A*, 4 inches in diameter and ¾ inch wide, one corner of which is rounded with a radius of ⅜ inch. The disk is carried in a forked holder as shown. This is put into the ordinary tool-holder of an axle lathe in which the axle is revolved at a speed of 500 revolutions per minute. The steel disk is then screwed hard against the journal and revolves with it. At the same time it is fed longitudinally toward the rounded corner. The effect is to condense and solidify the surface of the journal and give it a much better wearing surface than it would have if it was not burnished. It has been used to a very considerable extent with excellent results. It was devised by Mr. John H. Hindman, foreman of the shop.

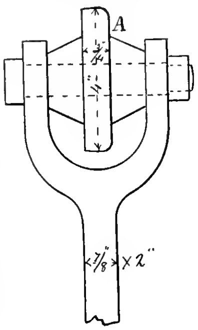


Fig. 2.

Many of the wheels used in passenger service are ground on their treads, especially those wheels which are cast in contracting chills. The slightly uneven surface of the tread, which is left by this kind of chill, causes the wheel to make a sort of whirring sound in running on the track. The grinding overcomes this objectionable sound.

THE CABINET SHOP.

This is 75 by 160 feet and is equipped with the usual machinery found in such establishments. It is admirably lighted and arranged and is capable of turning out a large amount of work.

THE TIN, TRIMMING AND UPHOLSTERY SHOPS.

These departments are housed in a building 200 by 75 feet, which gives ample room and light. The upholstery department is in a loft at one end of the building.

(To be Continued.)

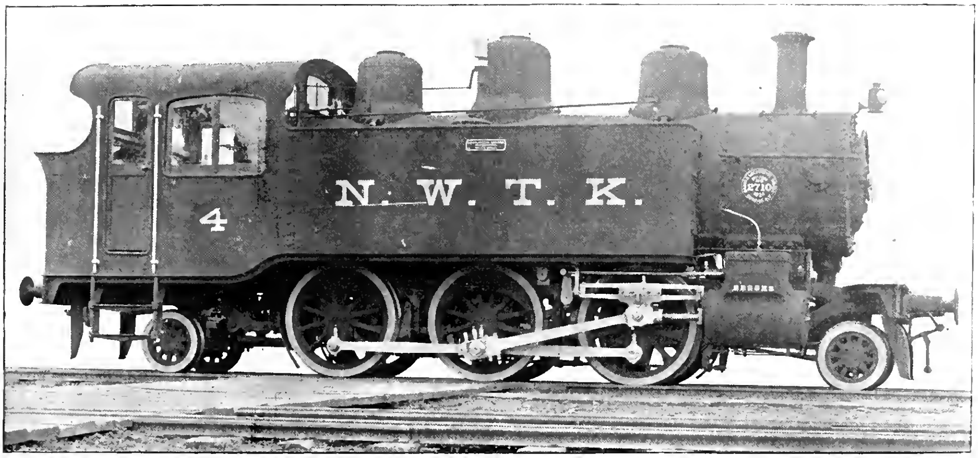
The Operating Mechanism of the New Rock Island Bridge.—A Correction.

In describing last month the operating mechanism of the Rock Island Bridge we reproduced a diagram of end jacks which we stated showed the construction of those in use on that bridge. We should have stated that the particular jacks shown were designed for a much smaller and lighter bridge and the engraving was only introduced to illustrate the general type of jack in its elementary form. The few dimensions given on the cut would indicate that a mistake had been made, but that no injustice may be done Mr. Modjeski or Messrs. G. P. Nichols & Brother, we make this correction.

Double-End Side Tank Locomotive for Japan—Brooks Locomotive Works.

Through the courtesy of the Brooks Locomotive Works we present herewith a photograph of one of the two engines they have just shipped to Japan. As will be seen, the engines have six-coupled wheeled, a two-wheeled radial leading track and a two-wheeled trailing truck also. The water tanks are on each side of the boiler and the general finish of the cab, dome and sand-box casings, stacks, etc., suggest European practice.

The gage of the road is 3 feet 6 inches. The cylinders are 15 inches in diameter by 22 inches stroke, and the driving-wheels are 48 inches in diameter. The boiler is straight and is 54 inches in diameter. It is of steel $\frac{7}{16}$ and $\frac{1}{2}$ inch thick and carries a pressure of 150 pounds. The firebox is also of steel and is 78 inches long and 29 inches wide inside of the ring. It is stayed by 1-inch radial stays. The tubes are of brass No. 14 B. W. G., $1\frac{3}{4}$ inches in diameter and $9\frac{1}{4}$ inches long, and there are 210 of them. The total heating surface of the boiler, is about 950 square feet.



Double-End Side-Tank Locomotive for Japan. Built by Brooks Locomotive Works.

The driving-wheel base of the engine is 10 feet 4 inches and the total wheel base 23 feet 8 inches. The weight on the drivers is 78,000 pounds, and on each truck 11,000 pounds, making a total of 100,000 pounds. This is with 1,200 gallons of water in the tanks and one long ton of coal in the coal-box at the rear of the cab.

In most respects the details are American. We notice several departures, however, such as a copper dry pipe and headlights and signal lamps of the Japanese standard. The couplings and buffers are English. The truck wheels are steel-tired and 26 inches in diameter. All axles and rods are of hammered iron. The cylinders and boilers are lagged with asbestos board. The cylinder casings are steel, as is also the steam chest cover casing. The smokestack is of iron with a copper top. The cab is of steel. The engine is equipped with the Le Chatelier water brake and steam and hand brakes on all drivers. The injectors are Sellers No. 7, and the rod packing is United States metallic.

The Richmond Compound Locomotive.

The "tramp" Compound of the Richmond Locomotive Works last month finished a service test on the Louisville & Nashville Railway and went to the Wabash at once for experimental runs between St. Louis and Decatur, which will be watched with interest. The Lonisville & Nashville Railway has made no report yet, but it is understood that the engine has given perfect satisfaction and showed great fuel economy.

An Automatic Indicator on the Western Railroad of France.*

BY M. E. BRILLE,

Inspector of Material and Traction of the Western Railroad.

In order to obtain indicator diagrams from locomotives, a more expensive installation is required than in stationary practice, as independent of the apparatus for transmitting motion (mechanism often found to be delicate), there is the box and hand rails for the protection of the operator. M. Clerault, Chief Engineer of the Material and Traction of the Western Railroad of France, has thought that a gear could be constructed which had no mechanical connection with the crossheads, and with which the diagrams could be taken automatically without the presence of the operator at the front end of the locomotive. The apparatus which we illustrate herewith has been designed by M. Dubois, Assistant Engineer of Surveys, and by the author; it was constructed by the firm of Digeon from drawings furnished by the railroad company.

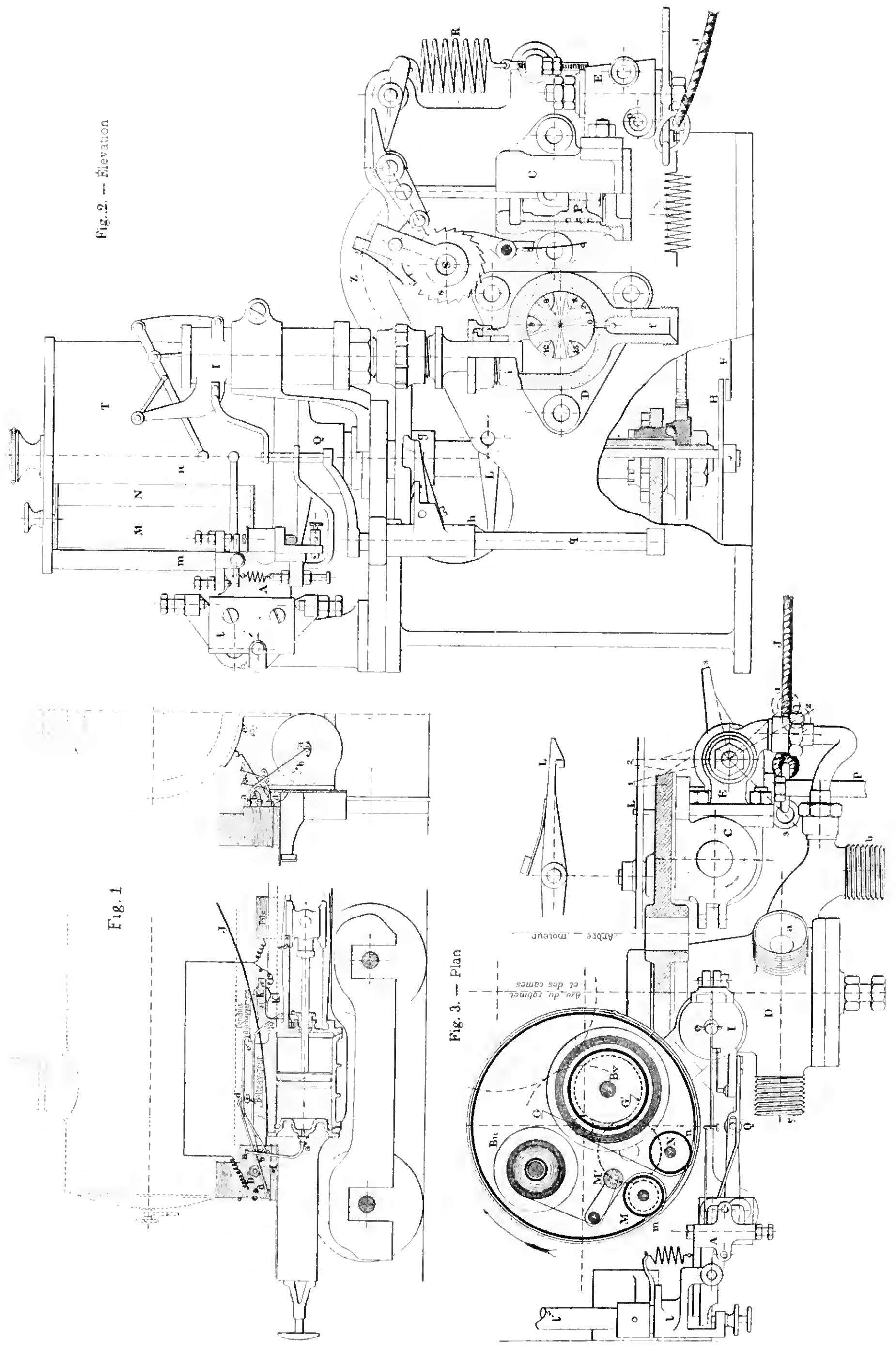
The mechanism employs an indicator for drawing the diagrams, but instead of making ordinary closed cards, it registers the pressures upon a drum which moves forward with a continuous motion during the tracing of a line, so that the curves approximate a sinusoidal shape. A chronograph records the dead points in the piston stroke. All this is done automatically, as well as the feeding of the roll of paper, the apparatus being started by a pull on a cord and automatically stopping itself when a cycle of operations is complete. The drum does not move with a speed exactly proportional to the speed of the piston at each point of the stroke, but has a uniform speed when in motion; that speed is, however, exactly proportional to the number of revolutions of the locomotive. The apparatus has no mechanical connection with the crosshead, as will be clear from the description of the details.

Fig. 1 gives the method of applying the apparatus to the locomotives; Figs. 2 and 3 are views of the apparatus itself; Figs. 4, 5 and 6 are sections of the distributing valve; Figs. 7 and 8 shows details of the drum mechanism, and Figs. 9 and 10 are examples of diagrams by the automatic and the ordinary indicator.

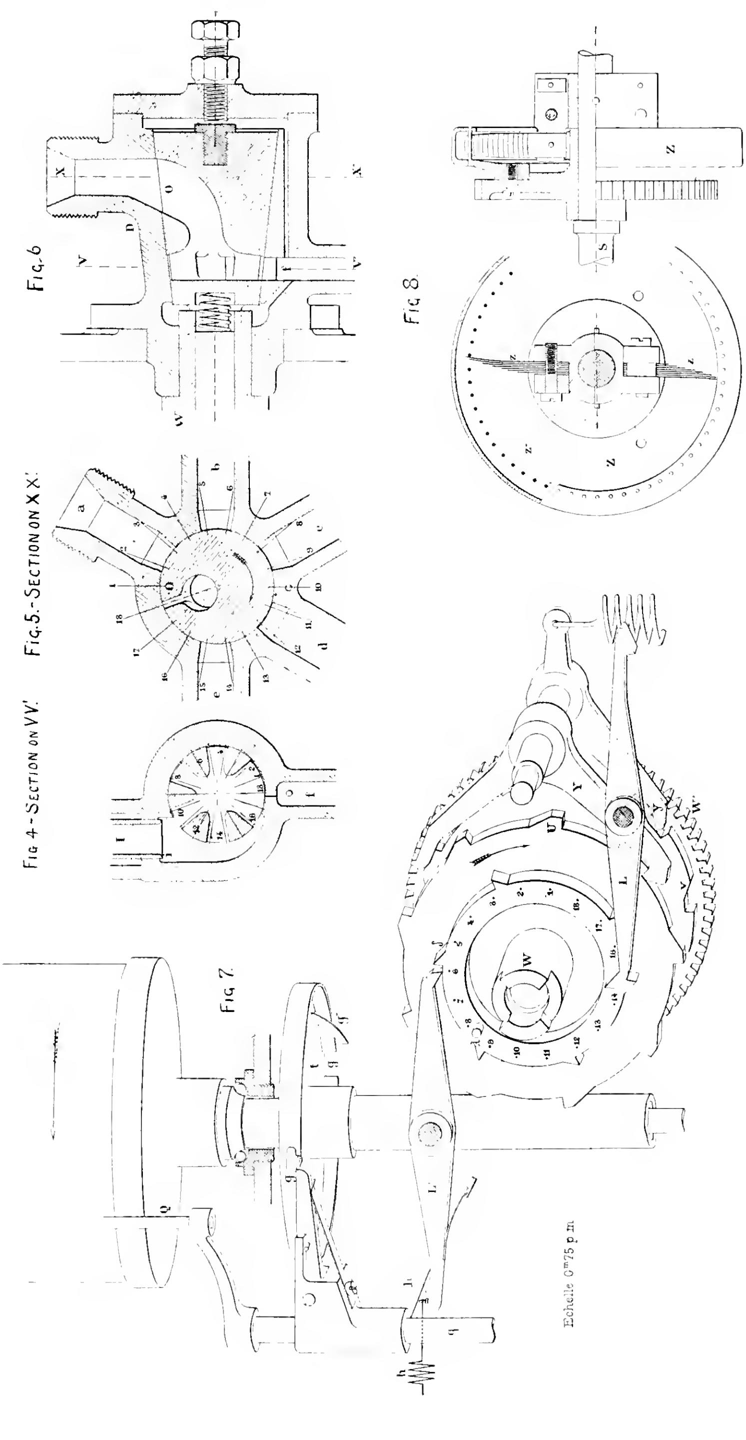
Before going into details it will help to make the description clear to say that all the lines of a single diagram are not taken during one and the same revolution of the locomotive; on the contrary, the pressure line for one end of the cylinder is drawn for nearly two revolutions as shown in Fig. 10, then the mechanism is put in communication with the other end of the cylinder and the process repeated, after which the steam-chest pressure card, exhaust passage card and atmospheric line are drawn by successive operations, each following the other automatically without the attention of the operator.

The ends of the cylinder, the steam chest and the exhaust pas-

*An article with this caption appeared in the *Revue Generale des Chemins de Fer* for September, 1895, which we have translated, re-written and condensed in the form here given.



AUTOMATIC INDICATOR ON THE WESTERN RAILROAD OF FRANCE.



DETAILS OF AUTOMATIC INDICATOR ON THE WESTERN RAILROAD OF FRANCE.

sage are all piped to the cock *D*, Figs. 2 and 3, and a port from the latter also connects with the atmosphere. A branch pipe from one of the cylinder pipes leads to the stop cock *E*. The latter is opened by a cord in the hands of the operator and has three positions; in the closed position all of the apparatus is idle; when pulled open as far as possible by means of the cord it connects the motor cylinder *C* with the steam cylinder of the locomotive, and also opens a port to the atmosphere; steam then blows through until all water of condensation is blown out, when the operator lets go of the cord and a spring partly closes the cock until its lever catches on the notch of the lever *L* (Fig. 3), where it remains until automatically released; in this third position the cylinder *C* is in connection with the locomotive cylinder, but not with the atmosphere, and its piston *P* makes a stroke for each stroke of the main piston, the admission pressure forcing the piston *P* up, and the spring *R* forcing it down as the pressure falls. The stroke of this piston is always great enough to turn the shaft *S* one notch of the ratchet-wheel *s*, and only one. This shaft has thus an intermittent motion, and from it are derived the movements of the remaining mechanism. These are chiefly two, the continuous rotation of the drum and the intermittent movement of the distributing valve. We will take up first the distributing valve.

This valve *D* is seen in Figs. 2 and 3, and sections of it are also given in Figs. 4, 5 and 6. It is a plug cock with one port *O* in the plug, which registers successively with the passages *a*, *b*, *c*, *d*, *e* in the plane *X X'*, Fig. 6, as it is turned, these ports connecting with pipes leading from the ends of the locomotive cylinder, steam chest, exhaust passage and (if so desired) from the boiler. The plug also has a series of ports in the plane *V V'* (Fig. 6) which communicate, sometimes alternately and sometimes simultaneously, with the passage *I*, leading to the indicator, and the passage *f*, leading to the atmosphere. The plug is adjusted to a bearing by a set screw and is forced against that screw by a spring and by steam pressure on the small end, obtained from the passage *I*. The plug is turned by means of clutch faces on the end of it engaging with similar faces on the driver *W*, Fig. 6 (seen also in Fig. 7). It is evident that if this cock is

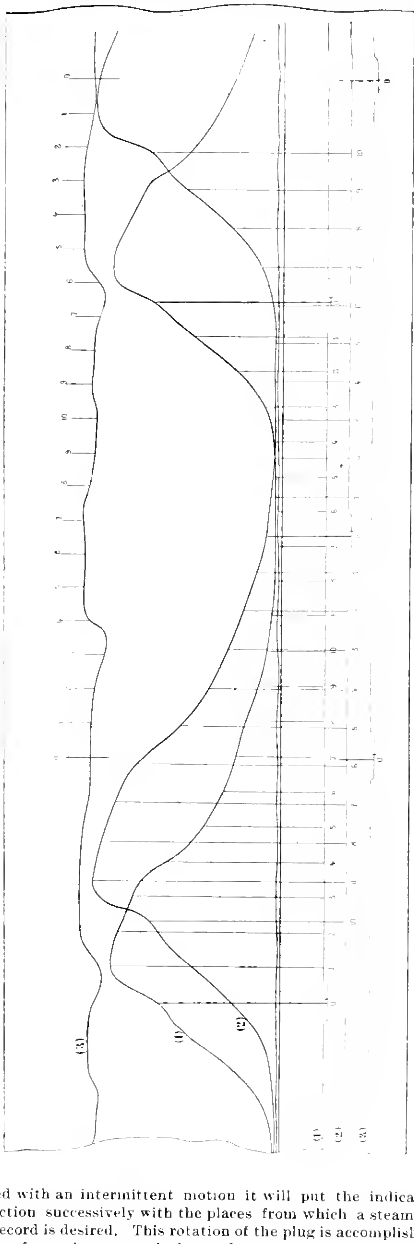


Fig. 9.—Diagram from Automatic Indicator.

rotated with an intermittent motion it will put the indicator in connection successively with the places from which a steam pressure record is desired. This rotation of the plug is accomplished by gearing from the motor shaft S and the 18 positions of the plug, marked in Figs. 4 and 5, are derived from the spacing of the teeth in the ratchet wheel S. Position 18 is the position of rest, the indicator being open to the atmosphere through the port f. The positions for taking cards are when the lines 3, 6, 9, 12 and 15 register with the port of f. It will be noticed from the lines indicating the other positions that each time the port f is closed it remains closed for nearly, but not quite, two whole positions (Fig. 4) and that during that time the indicator is in communication with some one of the ports a, b, c, d, e. This, as will be seen later, is to obtain a diagram covering nearly two revolutions.

The drum has a continuous motion obtained in an ingenious manner and illustrated in Fig. 8. On the motor shaft S is a loose gear carrying a ring Z, whose circumference is set with pins. Fixed to the shaft are two springs zz', the ends of which engage the pins mentioned. This gear drives the drum through intermediate shafts and gears. When the shaft S starts with its intermittent motion it at once takes a speed proportional to that of the engine. The drum, because of its inertia, cannot do this, and the springs deflect as shown at z'', even skipping from pin to pin until the drum gets up to speed. Then the springs by their elasticity permit the drum to revolve at a uniform speed, though driven from a shaft moving intermittently. Experiment has shown that during any single revolution of the drum its speed is constant, which is all that is required.

The paper for the drum is carried on the spool Bu inside of the drum (see Fig. 2), and passes over the roll M, thence around the outside of the drum, over the roll N, and onto the spool Bv. While the drum is revolving the paper is stationary on its surface until

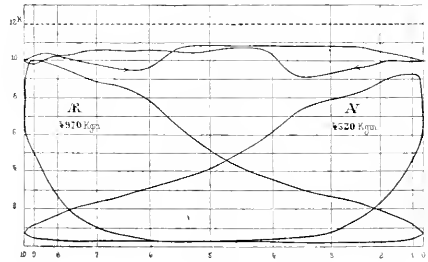


Fig. 10.—Indicator Diagram Corresponding to Automatic Card in Fig. 9.

the cycle of operations are practically complete, when the paper is shifted automatically. The gear G is on the upper end of a shaft passing up into the drum through the hollow spindle of the latter. On its lower end is a disk H, seen in Fig. 2. When the moment for changing the paper arrives, the brake F is brought into contact with the disk H and the motion of the shaft which had been carried around with the drum is arrested, the gear G standing still and the drum continuing to revolve the gear G' rolls over G and through the intermediate gear actuates the feed roll M, which take paper from Bu and roll up the used paper on Bv. The latter has a friction drive from the gear G' which keeps the paper tight. The roll Bu will hold from 10 to 15 meters of paper.

The diagrams are traced by metallic points, and the automatic control of both the indicator and chronograph tracing points is accomplished through the mechanism shown in Fig. 4. The ratchet and gear wheels U, V and W' are on the same axis as the distributor cock D, in fact, we have seen that the clutch face W rotates the cock. The motor shaft drives the gear W' which is loose upon its axis and connected to the ratchet wheel U by a spring which exerts its force in the direction of the arrow. The gear carries the cam wheel V which by means of the lever y rocks the escapement Y and permit the spring to rotate the wheel U a half space at a time. As there are nine teeth on the wheel U the movement each time is $\frac{1}{18}$ of a revolution. By this arrangement the cock D is moved from one position to another with speed and exactness. The other cam on the same shaft, with teeth marked δ, actuates the lever L'. In its normal position this lever engages the arm h of the vertical shaft q and prevents the upper arm Q from throwing the tracing points (see Fig. 2) into contact with the paper on the drum. When the lever L' is operated by one of the teeth δ it releases this shaft and the and the spring h rotates the shaft, thus bringing the tracing points toward the paper. They do not immediately reach it, however, for the arm g prevents it by coming in contact with the rim of the disk t. It is not until g passes through the opening g' into the interior of the disk that the tracing points come into contact with the paper. The opening g' times with exactness the beginning of the card. The tracing points are thrown out of contact by the cam g'', which makes the arm g ride over the flange of the disk to the outside again.

The lever L (Fig. 4) is the same one seen in Fig. 3 which holds the cock E open until the cycle is complete. At the completion of the cycle the pin A strikes the lever L and causes it to release the cock E, which then closes and the entire mechanism stops.

The chronograph registers the ends of the piston stroke by means of an electric contact. It draws a straight line except that the

closing and opening of the circuit at the ends of the stroke cause an electro-magnet to pull down and then release the arm holding the tracing point, producing a "notch" in the line.

The character of the indicator and chronograph diagrams are shown in Fig. 10, and Fig. 9 is a corresponding diagram from the ordinary indicator. The diagram from the front end of the cylinder is distinguished from the one from the rear end by the fact that on it the dead points of the piston correspond with the points of admission, while on the other they occur in the period of exhaust. The chronograph records for each operation are placed one below the other for clearness. The chronograph record is not drawn during the operations of taking an exhaust passage card and drawing the atmospheric line. The "lag" in the electric apparatus has been determined for all conditions and tabulated so that the chronograph record can be quickly corrected for it.

The drum is so geared that it turns once for two revolutions of the drivers. Each diagram would thus represent two revolutions of the locomotive if it extended entirely around the drum. But the aperture occupied by the feed rolls prevents this and the tracing points are kept in contact for somewhat less than the two revolutions of the locomotive. The actual length of the diagram for one revolution of the drivers is 20 centimeters (about 7⅞ inches).

A complete cycle of operations by the automatic indicator takes place in 160 revolutions of the locomotive. Many of these revolutions take place during periods of exhaust from the indicator pipes or while the pipes are being blown out. Thus 50 revolutions takes place after the operator pulls the cord during which the apparatus automatically gets rid of the water of condensation, the drum gets up to regular speed, etc., and the last 32 revolutions of the 160 are employed in tracing the atmospheric line and changing the paper. From the beginning of tracing the first line of the card until all the lines are complete except the atmosperic line (in other words the two ends of the cylinder, the steam chest, exhaust passage and the boiler pressure line) the locomotive drivers make 74 revolutions.

It will be noticed that the uniform motion of the drum results in equal spaces on different parts of the diagram not representing equal displacements of the locomotive piston. This has the advantage of making the setting of the slide valve and the study of events near the end of the piston stroke more easy by these diagrams than by the ordinary ones, but to figure the power exerted by the engine the diagram must be redrawn into one of ordinary form. To do this a chart is employed by which the abcissas and ordinates of the one diagram can be readily converted into the other.

The apparatus has been in use some time and notwithstanding its apparent complication has done good work. It has been employed regularly by the department of material and traction of the Western Railroad for months, and records have been taken in all kinds weather, by day and by night, and on many different types of locomotives.

The Report of the Secretary of the Navy.

The annual report of Secretary Herbert asks Congress to authorize the construction of three more first-class battle-ships and twelve torpedo boats. He recommends that the battle-ships have an extreme deep load draft of only 23 feet, this draft being derived from considerations of strategy on the Atlantic and Gulf coasts. This is in line with the policy of the Navy Department for some time past, but the reductions in the draft of recent ships has not been sufficient to accomplish the desired purpose, the last ships being of 2 feet less draft than the earlier ones, or 25 feet extreme. The first-class battle-ships already built are all right, but the necessity of having a part of the fleet of such draft as to freely enter the harbors of the Gulf is evident. The War College investigated this subject thoroughly and in its report said:

"The close study of the Gulf of Mexico which has been carried on by the Department's orders during the last year shows it to be essential to the success of defensive naval campaigns that we shall be able to use for our fighting ships those harbors which nature has provided. Although possessing bases for fleets in that region, the fact that there is not enough depth of water for our fighting ships to enter them will render them of but slight benefit to us.

"It is submitted further that the artificial deepening of channels and entrance is not a good solution of this difficulty, because such dredged channels are of necessity narrow, easily blocked, and very sensitive to injuries from an enemy or the elements.

"The effort to remedy a shoal entrance by dredging a narrow channel across the bar seems unwise as far as naval and military questions are concerned, and the true remedy, in the opinion of the War College, lies in decreasing the draft of the warships to a point permitting them to enter.

"The college, therefore, respectfully suggests that future ships of war be planned for an extreme deep-load draft, with maximum coal supply on board of 23 feet, and submits that considerations of strategy upon our Atlantic and Gulf coasts render this an essential to successful naval campaigns.

The policy of the naval authorities for the present is to confine construction to battle-ships and torpedo-boats.

The Secretary asks Congress to authorize the building of a dock at Norfolk large enough to take in the largest vessels in the navy. This, he urges, should be built of concrete. He also believes that a navy yard should be established at some Gulf port.

The supply of ammunition for the navy is at present limited to a complete outfit for each vessel. The last Congress appropriated $250,000 for spare projectiles, but the Secretary is so impressed with the need of immediately providing at least double the present stock of powder and projectiles on hand that he urges an appropriation for this amount and that the purchase be made at once, in this country if possible, but abroad if our own manufacturers cannot supply it quick enough.

All ships designed to carry torpedoes are now supplied with them and there is a good supply of torpedoes on hand.

The progress in gun construction is given as follows:

"During the past four years 213 guns have been manufactured of all calibers, as follows: Seventy 4-inch, 71 5-inch, 6 6-inch, 45 8-inch, 1 10 inch, 8 12-inch, 12 13-inch. Including the 20 sets of 4-inch, 35 sets of 5 inch, 50 sets of 6-inch and 2 sets of 8-inch gun forgings, for which contracts have been awarded, we have in course of manufacture at this date 196 guns of all calibers from 4-inch to 13-inch. Of these, 63 guns are for the auxiliary naval cruisers, for which an appropriation was made at the last session of Congress. In addition to the above 100 3-inch field guns, for landing and boat service, are in hand and will be completed in the near future. March 1, 1893, 116 guns of all calibers were mounted aboard ship. At present, including some temporarily landed pending repairs of vessels, there are 366."

"Our projectiles of all calibres are manufactured by private firms of which there are at least seven possessing the necessary plant and skill for the manufacture of the various kinds required. Armor-piercing shells are now being supplied to the navy, capable of withstanding the test of passing through a caliber of hard-faced armor quite as well as those of earlier manufacture did that of passing through a calber of simple steel. A new type of shell, called semi-armor-piercing, has also been developed to meet the modern practice of armoring large portions of heavy ships with armor from 4 to 6 inches thick. These shells will carry large bursting charges through half a caliber of armor and explode after having gone through."

The present strength of our navy is 42 vessels of 137,850 tons' displacement. The experiments made with liquid fuel by Engineer-in-Chief Melville have led to its trial in a tug, now being built at Norfolk, and a torpedo-boat under construction at Herreshoff's.

For the relief of the engineer corps it is urged that the limit to their number be increased from the present number of 194 to 250.

Electricity on the New York, New Haven & Hartford Railroad.

Recent dispatches in the daily press state that while the leading officials of the New Haven road will not give the details of the reported three-rail electrical branch between New Britain and Hartford, via Berlin, they admit that the power station is practically assured, and that similar power-houses will be constructed in a short time on various branches of the main lines in this State. President Charles F. Clark, of the road, was interviewed and said:

"I am not yet prepared to say that work will immediately be begun on the erection of the power station at Berlin, but its erection has been under consideration for some time. An announcement that work will be immediately undertaken may or may not be made within a short time.

"The general policy of the New Haven road relative to the introduction of electricity as a motive power may be given as follows: Electricity as a motive power is foreshadowed in the last annual statement of the road. On the south shore branch of the Old Colony system, the current has been successfully and economically conveyed in a third rail, insulated upon wooden blocks in the center of each track. The results have surprised experts, and it is now probable that a third rail will be laid at various points upon the company's property during the year to come. Short branches to the centers of business and population may then be constructed from the company's lines."

The "Engineer" Horseless Road Carriage Competition.

Our contemporary *The Engineer* (London) has arranged a road carriage competition to take place during the month of May, 1897. It will award 1,100 guineas in prizes as follows:

A.—For the best mechanically propelled vehicle constructed to carry—including the driver—four or more persons, the total weight, when fully loaded, not exceeding two tons, a prize of 350 guineas will be given.

B.—For the best mechanically propelled vehicle constructed to carry either one or two or three persons, the total weight, when fully loaded, not exceeding one ton, a prize of 250 guineas will be given.

C.—For the best mechanically propelled vehicle constructed to carry, in addition to the driver, not more than one ton of goods, or parcels, the total weight, when fully loaded, not exceeding two tons, a prize of 250 guineas will be given.

D.—For the best mechanically propelled vehicle constructed to carry, in addition to the driver, five hundredweight of goods or parcels, the weight, when fully loaded, not exceeding one ton, a prize of 150 guineas will be given.

Supplemental.—For the vehicle, whether for passengers or goods, propelled solely by a motor actuated by the vapor of oil or spirit, having a lower specific gravity than 0.8, or a flashing point lower than 73 degrees Fahrenheit, Abel's test, and constructed to satisfy the requirements of any act of Parilament, and the rules to be made thereunder for the time being respectively in force, which, in the opinion of the judges, best satisfies the purpose for which it is built, a prize of 100 guineas will be given.

The carriages must be delivered at the Crystal Palace, Sydenham, England, during the week prior to May 24, 1897, and entries must be made before April 1. Inspections and trial runs will be made at the Palace and the road race will take place about May 31 over a route to be named three days before the race. The distance will be at least 200 miles. The judges in making the awards will take into consideration the following: *a*, distance run without taking on supplies, freedom from stoppages; *b*, design and workmanship of machinery and carriage; *c*, safety; *d*, simplicity, durability, accessibility and facilities for repairs, absence of offensive smells, and of excessive vibration; *e*, time occupied in getting to work and ease of starting; *f*, speed up to ten miles per hour and hill climbing; *g*, control, certainty of steering gear and efficiency of brake gear; *h*, weight; *i*, first cost and cost of operation; *j*, general efficiency.

Full particulars can be obtained from the publishers of *The Engineer*.

Piece-Work in Repair Shops.

The claims in favor of piece work set forth in our article on the Altoona Shops, last month, find corroboration in an article on the same subject by Mr. C. F. Webelacker, in the *Street Railway Journal*. His experience is in street car work, but the story is much the same. His opening paragraph is suggestive to those who have to contend with small shops and overtaxed facilities. He says:

"Some time ago the writer was brought face to face with the fact that the shop facilities with which he was attempting to handle the maintenance of equipment for his company were entirely inadequate. The amount of equipment and the mileage was continually on the increase and there was no prospect of an immediate increase in the size of the shop. The problem before him was to make the necessary repairs on upward of 600 cars in a shop where the pit room would accommodate 16 cars at a time, and in addition to making the regular running repairs, to carry on a very considerable equipment business. The first step, of course, was to improve the facilities for handling the various parts with an eye to expediting the work. This effort was, however, very poorly seconded by the workmen. They seemed to consider each innovation as simply a scheme to lay off men and consequently were very loath to find any virtue in improved machinery."

As experience had shown that the amount of work turned out could not economically be increased by adding to the shop force, piece-work was resorted to. The extent to which the capacity of the shop was increased, even with a reduced number of men, can be realized from the fact that where 66 men working seven days a week and more or less overtime had, under day-work, averaged $11\frac{9}{10}$ cars repaired per day, 45 men on piece-work, working $5\frac{1}{2}$ days per week, turn out on the average $12\frac{4}{10}$ cars repaired per day. The average cost per car has been reduced from $19.25 for labor to $15.14.

The price list was carefully worked out before the piece-work was inaugurated, and proved to be in the main correct. A complete system of supervision and recording was necessary, but it presented no unusual difficulties. The wages of the men averaged 10 per cent. higher with piece-work. At first some of the men were careless, but as they had to make good all their bad work without additional compensation, the carelessness soon disappeared. In fact, after the system was fairly under way the cars averaged a higher mileage between repairs than under the old system. The author concludes that "opposed to these advantages are the increased difficulty and labor in keeping time, and the increased inspection necessary; that these disadvantages are more than offset by the advantages, the figures above quoted plainly show."

The Electric Motors on the Brooklyn Bridge.

During the last month the new motor cars were put in regular service on the Brooklyn Bridge. Like most new installations they have had their series of mishaps, more illustrative of what is occasionally spoken of as the natural cussedness of things inanimate than of any defects of the apparatus. The first troubles arose from several derailments of the motor cars on the sharp curves at the terminals, due, it is claimed, to the newness and stiffness of the trucks. The delays culminated a few days ago in the breaking of a crosshead of a 2,000 horse-power engine in the street railway powerhouse from which the bridge cars were temporarily taking their current. But, notwithstanding these troubles the new motors have demonstrated their value.

The electric motors are used to perform the switching operations at the terminals of the bridge, while the cables haul the trains over the bridge as formerly. The motor cars are not any different in general appearance from the other cars, and there is one of these cars in each train. They take current from a third rail, and after the train has unloaded its passengers on the in-coming platform, the motors switch it over to the outgoing platform. After the passengers are taken on the motors start the train out of the terminal until the grips take the cables, after which the motors are idle until the other end of the bridge is reached. The motors being always coupled to their trains much time is saved in the switching operations over what was possible with the steam locomotives. When the cables are stopped, shortly after midnight, the motor cars are operated all the way over the bridge.

Each motor car is 45 feet long over all and weighs complete about 30 tons. The trucks are made by the McGuire Manufacturing Company, of Chicago, and each truck has two G. E. 50 motors. Each car has two K. 14 series parallel controllers. The third rail from which the current is taken is located about one foot from the outside rail, and is supported on insulators of vitrified clay placed on every fifth tie. It is an ordinary T-rail bonded with No. 0000 bonds. The return is through the track rails which are bonded with No. 0 bonds. The contact shoes are supported from an oak beam between the wheels on each side.

The contract for the electrical equipment called for power enough to take a fully loaded train weighing 120 tons across the bridge at a speed of 11.3 miles per hour (the speed of the cable). The grade is 3.78 per cent. at the maximum, and the motors have demonstrated their ability to do this work. When the double tracks and cables are put into operation it is expected that the headway of the cars will be reduced to 45 seconds instead of 90 as it present. Then there will be two incoming and two outgoing platforms at each terminal.

One of the New York *Sun's* European correspondents says that a German court made an odd ruling last month in a remarkable case of larceny. A man was accused of stealing several thousand amperes of electricity by tapping a light company's wires and using it to run a dynamo. The Court, on appeal, ruled that only a movable material object could be stolen, which electricity was not, and therefore the man was acquitted.

American Society of Mechanical Engineers.

The annual meeting of the American Society of Mechanical Engineers was held at the house of the society, 12 West Thirty-first street, New York, Dec. 1 to 4. The attendance was unusually large, the total enrollment on the register being 556.

The first session was held on the evening of Dec. 1 (Tuesday), at which time the President, John Fritz, read the annual address, the subject being "The Progress in the Manufacture of Iron and Steel in America and the Relations of the Engineer to it." An abstract of this address is published elsewhere in this issue.

WEDNESDAY MORNING.

The first business session of the meeting was held on Wednesday morning. The report of the council gave the total membership as 1,762, as follows: Honorary members, 16; members, 1,342; associate members, 104; junior members, 300. There are also 65 life members.

The council reported that its efforts to secure proper recognition for the naval engineers of the United States had resulted in a memorial to Congress addressed to the Committee on Naval Affairs of each House, and a circular sent to members of the society asking their individual co-operation.

The council has appointed a committee, consisting of Messrs. Coleman Sellers, Prof. John E. Sweet, Charles T. Porter, George M. Bond and Coleman Sellers, Jr., to prepare material to be used in opposing legislation looking to the compulsory adoption of the metric weights and measures.

The reports of the Finance Committee and Library Association were gratifying. The total receipts for the year were $28,869. The report of the tellers of election showed this result: President, Worcester R. Warner, Cleveland, O.; Vice-President, E. S. Cramp, Philadelphia; S. T. Wellman, Cleveland; W. F. Durfee, New York; Treasurer, Wm. H. Wiley, New York; Managers, H. S. Haines, Atlanta, Ga.; Gus C. Henning, New York; A. W. Robinson, South Milwaukee, Wis.

The committee on tests of fire-proof materials, methods of testing and standard methods of boiler testing reported progress. A communication from the Secretary of the American Steel Manufacturers' Association stated that the decimal gauge had been adopted by the association.

The first paper was that of Sir Henry Bessemer entitled:

AN HISTORICAL AND TECHNICAL SKETCH OF THE ORIGIN OF THE BESSEMER PROCESS.

The great impetus given to the manufacture of steel by the introduction of this process and the vast developments that have resulted from it naturally make this sketch by the inventor of the process one of great interest. The paper illustrates some of the apparatus used in the early experiments, beginning with the reverberatory furnace for improving cast iron by fusing in the bath broken-up bars of blister steel. This was in 1855. In the alterations of this furnace, from time to time, an arrangement of admitting air at the bridge was tried to complete the combustion of the gases, and it was noticed that the bath was partially decarburized. Later on some pieces of pig which had remained unmelted in spite of the great heat of the furnace remained unfused when a greater quantity of air was admitted, but when broken up were found to be thin shells of decarburized iron, having been reduced to this state by air alone. This gave a new turn to the experimental work which finally resulted in seven hundred weight of iron being decarburized without the use of fuel. The description of this first blast is interesting:

"All being thus arranged, and a blast of ten or fifteen pounds' pressure turned on, about seven hundredweight of molten pig iron was run into the hopper provided on one side of the converter for that purpose. All went on quietly for about ten minutes. Sparks, such as are commonly seen when tapping a cupola, accompanied by hot gases, ascended through the opening in the top of the converter, just as I supposed would be the case, but soon after a rapid change took place. In fact, the silicon had been quietly consumed, and the oxygen next uniting with the carbon, sent up an ever-increasing stream of sparks and a voluminous white flame; then followed a succession of mild explosions, throwing molten slags and splashes of metal high up into the air, the apparatus becoming a miniature volcano in a state of active eruption. No one could approach the converter to turn off the blast, and some low, flat zinc-covered roofs close at hand were in danger of being set on fire by the shower of redhot matter falling on them. All this was a veritable revelation to me, as I had in no way anticipated such violent results. However, in ten minutes more the eruption had ceased, the flame died down, the process was complete, and on tapping the converter into a shallow pan or ladle, and forming it into an ingot, it was to be wholly decarburized malleable iron."

From this point the account deals chiefly with the perfecting of the process, and references are made to other inventors and their work. The author is a little severe on the work of Kelly and Mushet and in the discussion of the paper several members well versed in the early history of steel-making took exceptions to the way in which other inventors were treated in the paper. Mr. W. F. Durfee was a participant in the work of Kelly and ably defended that inventor. Messrs. Allen Stirling, R. W. Hunt and Wm. Kent contributed written discussions. The highest respect for Sir Henry Bessemer was expressed, but the facts about the work of others were clearly stated.

ANCIENT POMPEIIAN BOILERS.

This paper by Mr. W. T. Bonner, of Cincinnati, is descriptive of a number of boilers used by the ancients in heating water for domestic purposes. They were found in the ruins of Pompeii and are now in the National Museum in Naples. The most remarkable boiler is one in the form of a vertical cylinder 30 centimeters (about 12 inches) internal diameter and 42 centimeters (about 16½ inches) high. It has a water-tube grate, and a round firebox with a semi-spherical crown. This and the other interesting boilers described show, in the author's word, that "the water-tube principle, the crowning feature of the most successful boilers of to-day, was fully understood and appreciated by the Greeks and Romans two thousand years ago."

The discussion brought out information concerning a boiler that is even nearer to present practice; for Mr. Durfee stated that in the same museum there was a boiler whose firebox and tubes were arranged exactly like the common vertical boiler of the present day.

THE MOMENT OF RESISTANCE.

This paper was presented by Mr. C. V. Kerr, of Chicago, and opens with an argument in favor of the use of the term moment of resistance in computing the strength of beams instead of the moment of inertia. The author says that "A way out of the difficulty could be found in associating the resisting moment, as proposed by some and used by others, with the established bending moment, and in tabulating, for the use of engineers and architects, the values of R, as found directly by analytical or graphical methods from a given section of beam, in terms of stress and dimensions, or numerically when either the safe working stress in extreme fiber or unit stress at unit distance from the neutral axis is assumed and stated."

The paper also contains formulas for the moment of resistance of the regular geometrical sections and an analytical method for use on irregular sections.

METHOD OF DETERMINING THE WORK DONE DAILY BY A REFRIGERATING PLANT AND ITS COST.

The author, Mr. Francis H. Boyer, discusses the methods employed at the refrigerating plant at the abattoir of John P. Squire & Company, East Cambridge, Mass., installed by the De La Vergne Refrigerating Machine Company during the winter and spring of 1890 and 1891. It is composed of two machines rated by the builders as 150-tons ice-melting capacity each daily, or a combined capacity of 300 tons, this to be accomplished by running 24 hours daily with a return pressure of 26 pounds above atmosphere, or $40\frac{7}{10}$ pounds pressure absolute, running at 40 revolutions per minute. The size of the gas-compressing cylinders were 16 inches in diameter and 32 inches stroke, and, being double-acting, there were four gas cylinders all told.

The condition and amount of work being done is indicated by the back or return pressure of the gas—this condition being maintained by the speed of the gas pump—the engines being directly connected and constructed to allow of a variation of speed from 15 to 75 more revolutions per minute.

It became desirable to establish a method to obtain the amount of work accomplished daily in order to arrive at the expense of operation, and to make comparison with results of other departments of the abattoir. By taking the cubic displacement of the compressors with a given amount of return pressure the amount was obtained easily.

A copy of the engineer's logs for July 18, 1896, is given and explained.

The object of the paper is to ascertain the amount of work done under the varying conditions of service and reducing this to the standard set of conditions. The average number of revolutions is 40; 26 pounds per square inch is the return pressure for a given result and 150 tons is the rated capacity of the machines, when the fixed conditions are maintained. The actual hours, revolutions and return pressure can be inserted as numerators in the following equation :

$$\frac{\text{Hours.}}{24} \times \frac{\text{Revolutions.}}{40} + \frac{\text{Return pressure.}}{26} \times \frac{\frac{\text{Tons refrigerating.}}{150}}{1}$$

In determining the cost of operating several tests had been made on the boiler and engine plant, which showed an average of $10\frac{47}{10}$ pounds of water vaporized per pound of coal consumed, Pocahontas coal from Virginia being used, and with an efficiency of $16\frac{44}{100}$ pounds of steam per hour per horse-power, or $1\frac{56}{100}$ pounds of coal per hour per horse-power.

The total expense for operating is taken monthly from the store-room accounts ; from the year 1894 we have the following :

Tons of refrigerating produced	48,466½
Cost of maintaining refrigerating department, including annual repairs	$28,471 63
Average cost per ton for refrigeration for 1894, cents	$58\frac{7}{15}$

The monthly statement for that year shows that the cost per ton varied from a maximum of 86 cents to a minimum of 24 cents, the fluctuation depending upon the quantity required.

THE PROMISE AND POTENCY OF HIGH-PRESSURE STEAM.

This is an elaborate paper by Prof. R. H. Thurston, in which he reviews the economy obtained for increasing steam pressures up to the present time, and gives his views of the probable result of a still further increase. He comes to the conclusion that the final limitation to increased steam pressures will be a financial one rather than a mechanical or thermal one—that is to say, that ultimately the increase in the cost of boilers and engines will offset the gain in economy of operation. In his paper he gave an account of a boiler and engine built at Cornell University for steam at 500 pounds' pressure.

This was the closing paper of the session.

Wednesday Afternoon and Evening.

The afternoon session was a memorial meeting, in memory of the late Mr. J. F. Holloway. Secretary Hutton had prepared a brief sketch of Mr. Holloway's life, and he was followed by others, who testified to the respect and esteem in which Mr. Holloway was held by all who knew him. His genial and kind-hearted manner to all with whom he was associated, his genuine interest in the welfare of others and his charming personality will long keep his memory bright in the minds of his many friends.

In the evening there was reception at Sherry's, which proved to be an enjoyable occasion and was well attended.

Thursday Morning.

EXPERIMENTAL INVESTIGATION ON THE CUTTING OF BEVEL GEARS WITH ROTARY CUTTERS.

This paper was contributed by Messrs. F. R. Jones and A. L. Goddard, of Madison, Wis., and gives the results of experiments made to determine the angles at which the gear cutter should be set for the final operations on a bevel gear cut in a universal milling machine. These final operations consist of cuts first on one side and then on the other side of the teeth, and the setting of the machine is generally done by a "cut and try" method. The authors, as the result of their experiments, constructed a diagram from which the settings can be accurately determined.

CALIBRATION OF A WORTHINGTON WATER METER.

In this paper Mr. J. A. Laird of St. Louis gives the results of a series of meter calibrations extending over more time than any heretofore presented to the society. The meter tested was a Worthington made entirely of brass, for hot water, and bought for testing purposes. It was used to measure the feed water during the two 30-day duty tests on the Allis engines at the Chain of Rocks pumping station, St. Louis.

The tests show that the maximum error was 2½ per cent., but this was unusual, and the author is of the opinion that the records of his work show that with careful calibration results can be obtained with a Worthington meter that will not be in error by more than ½ of 1 per cent.

CONTRACTION AND DFFORMATION OF IRON CASTINGS IN COOLING FROM THE FLUID TO THE SOLID STATE

is the title of a paper by Mr. Francis Schumann, of Philadelphia, in which the relations between the form of castings and their contraction and deformation in cooling is dealt with. The author first gives the general laws and discusses the contraction of prisms. Among the constituents of iron, carbon has the greatest influence upon the rate of contraction when in a combined state, while an increase in free carbon has the opposite effect. Increasing the silicon up to 10 per cent. causes the iron to become brittle and weak and increases contraction. Sulphur tends to change the carbon into a combined state and hence increases contraction. Phosphorus has little effect upon the carbon, but it lessens the rate of contraction and diminishes the strength of the iron. Manganese up to 1 per cent. has little effect, but when it reaches 1½ per cent., and the iron is low in silicon, it tends to hardness and increased contraction. Repeated remelting increases the rate of contraction. Formulas are given based on the results of actual measurement of castings of various sizes from small sections up to some of nearly 600 square inches. The conclusions of the author are that the deformation of prisms due to unequal contraction can be overcome by providing counter-deformation in the pattern or by the addition of parts that can easily be removed from the casting; that in complex machinery castings the design should be so modified or chosen that these will result in the least differences in cooling, sudden changes in form resulting in severe stresses, which should be avoided; that imperfetly proportioned flanges, ribs or gussets added to the main body of a casting, for either the purpose of increasing the strength or connections, may be sources of weakness; and, finally, that greater attention to the laws of cooling and correct forms and proportions of castings will result in increased strength and economy, besides the avoidance of annoying crooked castings and mysterious breakdowns.

In the discussion which followed, Mr. Henning described Mr. Keep's method of making his test bars. He also showed that the work of Mr. Schumann was in line with the work of the Committee on Testing. Mr. John Brashear spoke of his difficulties in casting glass for lenses, and talked interestingly of the manner in which cooling strains revealed themselves in the glass castings by means of the polariscope. He believes that if a special furnace was constructed for the heating and slow cooling of test pieces of cast iron much valuable information would be obtained. President Fritz and several other members also took part in the discussion.

A TWO HUNDRED-FOOT GANTRY CRANE.

This paper we will publish in abstract next month.

THE WASHING OF BITUMINOUS COAL BY THE LUHRIG PROCESS.

This paper we will also publish in abstract next month.

FRICTION HORSE-POWER IN FACTORIES.

In this paper the author, Mr. C. H. Benjamin, of Cleveland, gives the results of a series of experiments made under his direction by Messrs. McAllister and Morley, of the Case School of Applied Science. The investigation included 16 different establishments, among which were stamping mills, bridge works, machine shops, etc., etc. Cards were taken from the engine during the day when under load, and at noon cards were taken with the engine running light. The shafting was all inspected and its

length and diameters, number and length of belts and other data collected. The paper contains the results in tabulated form. The percentage of the total power required to drive the shafting in the group of shops that could be classed under heavy machine work was 62.3, and in the group of light machine work it was 55.1 per cent. The author says that in ordinary machine shops the following rules if carried out would effect a saving of fuel by reducing the friction:

1. Use pulleys of large diameter on counters and narrow fast-running belts.
2. Use nothing but the best oil, and plenty of it, catching all drip, and either purifying it or using it for some other purpose.
3. Have all the shafting and counters oiled regularly, and do not depend too much on automatic oiling.
4. Inspect line shafts from time to time, and see that they are in line and can be turned easily.

Thursday Evening.

SOME SPECIAL FORMS OF COMPUTERS.

This is a description by Mr. F. A. Halsey of computers provided with logarithmic scales similar to a slide rule, but each is designed for the solution of a special set of problems and the scales are sufficiently numerous to take care of all the factors, so that one setting will enable the operator to read off the result, instead of solving the problem by several steps, as would be required with the common slide rule. Moreover, the scales are long enough to cover all probable values of the quantities, so that there is no trouble in locating the decimal point. A gear computer is illustrated as an example and it contains six scales, one for each of the factors, pitch of tooth, face of tooth, revolutions per minute, diameter of gear, pressure co-efficient, and horse-power. The advantage of these Cox computers, as they are called, is very great where problems of a similer character must be solved frequently in the course of business.

RUSTLESS COATINGS FOR IRON AND STEEL.

This is the fourth paper on this subject presented to the society by Mr. M. P. Wood, and deals chiefly with the case of corrosion in the British steamer *Glencairn*, a steel vessel which, while loaded with "burnt ore," struck a rock and sunk on the beach in Scallaster Bay. Though raised in six days the corrosion was so great that all the cast-iron surfaces of her machinery were softened to the depth of $\frac{3}{32}$ of an inch to such an extent that they could be cut with a knife. Even the cylinders had to be rebored to remove this soft material. All steel work was also deeply pitted where bare, but wherever surfaces were painted they were untouched. The cause of the corrosion was the sulphate of copper in the burnt ore. Before going into the details of this remarkable case, the author points out the importance of the general subject in view of the skyscrapers now being erected in large cities and the great bridges projected over the East and North rivers at New York. He evidently believes the present methods of protection of steel in these large structures are unsatisfactory. Next to a good paint, the method of applying it is of importance, and he states that a poor paint properly applied will give better results than a good paint improperly applied to a surface not properly prepared for it. He condemns linseed oil free of pigment, and also oxide of iron in any form.

In the discussion one or two cases were cited showing the good effect of painting, but much of the discussion turned upon the joints for wires used in bridge cables, a point which the author had touched upon in his paper.

A METHOD OF DETERMINING SELLING PRICE.

The purpose of this paper, by Mr. H. M. Lane, of Cincinnati, is to propose a method by which the conditions affecting the final result of a year's business may be shown in a simple manner at the end of each week or month. It is not a substitute for bookkeeping, but an auxiliary for the convenience of the manager relating to organization and operation. The method is to prepare an annual estimate of the business in which all the items of expenditure and receipts are enumerated and the getting out blanks for weekly or monthly use on which each of these items appears. The blanks if in monthly form have one column for each month and in that column two spaces for each item. The upper of these spaces is immediately filled by the estimated item divided among the 12 months. The other space is for the actual figures resulting from the business. Thus at any time the state of the business can be known and accurate and intelligent supervision is made possible of each expenditure in its relation to the year's business.

TESTS OF FIRE-PROOFING MATERIALS.

The tests recorded in this report have already been published in our columns (see September number page 228).

Friday Morning.

THE EFFICIENCY OF THE BOILER GRATE.

The final session opened with the reading of a paper with the above title, by Mr. W. W. Christie, of Paterson, N. J. The paper contains data from 108 carefully made boiler tests. The rates of combustion vary from from 4.7 to 57 pounds per square foot of grate and the author finds that the most economical rate of combustion for hard coal to be 13 pounds and for soft coal 23.8 pounds per square foot per hour.

The author also gives some figures on chimneys.

In the discussion Mr. William Kent condemned the paper as wrong in many particulars. He said there were errors in the data that were obvious, that even the average line of the diagram was wrong, and that if the doubtful tests were eliminated, the results would not support the author's conclusions.

EFFICIENCY OF BOILER HEATING SURFACE.

In this paper, Mr. R. S. Hale, of Boston, discusses the formulas of Rankine, Clarke, Isherwood, Carpenter and Emery for boiler efficiency and in doing so goes more deeply into mathematics than would seem advisable under the circumstances. Those who know anything about boiler heating surfaces know that our knowledge of their efficiency is not in such an advanced state as to warrant going through extensive mathemetical gymnastics with the data at hand.

In the discussion Mr. Geo I. Rockwood spoke of the use of economizers and said that in England the cost much less per square foot of heating surface than did the boiler, while in this country the reverse was the case. This explained their more general use in that country.

PAPER FRICTION WHEELS.

This paper is by Prof. W. F. M. Goss, of Purdue University, and, like all his contributions to technical literature, is of great practical value. He has made an experimented study of the power which paper friction wheels will transmit, employing for the purpose $5\frac{1}{2}$-inch, 8-inch, 12-inch and 16-inch paper wheels, all in contact with a 16-inch cast-iron wheel. The contact pressure varied from 75 pounds per inch width of contact to over 400 pounds, and the peripheral speed from 450 to 2,700 feet per minute. The results show that slippage of more than 3 per cent. is likely to lead to a stoppage of the driven wheel. The co-efficient of friction is apparently constant for all pressures up to a limit which lies between 150 and 200 pounds per inch width of contact. At 400 pounds its value is from 10 to 15 per cent. less than at 150 pounds. Friction wheels from 8-inch in diameter up give about the same co-efficient, but for 6-inch wheels it is lower by about 10 per cent., which would indicate that it would fall still more as the diameter is reduced. Variations in speed within the limits named do not affect the coefficient. The horse power that can safely be transmitted by wheels 8 inches or more in diameter is given as:

$$\text{H. P.} = \frac{150 \times 0{\cdot}2 \times \frac{1}{2}\pi\ d \times W \times N}{33{,}000} = .000238\ d\ W\ N$$

in which d is the diameter of the friction wheel in inches, W the width of its face in inches, N the number of revolutions per minute, 0.2 the safe coefficient of friction, and 150 the pressure of contact.

STEAM ENGINE GOVERNORS.

In this paper Mr. Frank H. Ball, of Plainfield, N. J., investigates the accelerating forces in governors from a practical standpoint. The three forces to be taken account of in modern governors he defines as centrifugal force, tangential accelerating force and angular accelerating force. These forces he discusses at some

length in a most clear and instructive manner. The necessity of including in the governor problem all the forces developed by the pivotal swing of the governing mass he illustrates in a very apt manner, by calling attention to the fact that while the centrifugal force may vary directly as the radius, the rule does not hold good during a period in which a change of radius takes place. This will be comprehended when it is borne in mind that during a sudden increase in radius the mass may take a path corresponding to a tangent, during which time the centrifugal force would be zero. Another and a very important modification of force that appears during the period of radial motion is that due to the great change in lineal velocity that necessarily follows a change in the radius of rotation, either with or without a change in the rate of rotation, and which develops an accelerating force acting on a tangent to the axis of rotation.

After completing his discussion of the forces and the effect upon them of different locations of pivotal points, the author arrives at the following conclusions: First, Centrifugal force is the most important governing force, because it is indispensable; second, Angular accelerating force is next in importance, because it is an unqualified help as an actuating force, and its practical usefulness is limited only by constructional considerations; third, Tangential accelerating force is of questionable utility, because of the disturbing forces that it is almost sure to put in operation.

Perhaps we had better explain the meaning of the term "angular accelerating force" used by the author. If a governor weight is in the form of a mass concentrated at its center of gravity, this force cannot exist, but if as an illustration we assume the weight to be in the form of a bar of some length, it is evident that for each complete rotation of the governing wheel the weight has passed through 360 degrees of rotation around its own center of gravity, and the longer the bar or the further its mass is disposed from its center of gravity, the greater is the force developed by the "angular accelerating force" under a given set of conditions.

THE METRIC VERSUS THE DUODECIMAL SYSTEM.

This is a very valuable paper by Mr. George W. Colles, in which he reviews the facts in regard to the past history and present status of our own system of weights and measures and the metric system. His own opinions do not favor the metric system. His paper is very long—98 pages—and we confess that we have not gone over it carefully enough to notice it at this time; we may take it up again.

ALUMINUM BRONZE SEAMLESS TUBING.

This paper, presented by Mr. Leonard Waldo, describes this material and the author exhibited samples of it. He states that the bronze appears to be not a mere alloy, but a chemical combination.

The above paper concluded the programme for the meeting, but before it adjourned, Mr. F. H. Stillman presented the society with the first hydraulic jack ever made. It is one of Mr. R. Dudgeon's jacks and is in good condition. After this presentation the meeting adjourned.

Railways and Car Building in Japan.

In Japan, there are now 2,188 miles of railways working, 1,882 miles under construction and 1,342 miles of proposed lines. The gage is 3 feet 6 inches, and the rails are 60 pounds per yard. At present the question of widening the gage to 4 feet 8½ inches is being considered. The rolling stock is mostly of English make, but there are some American and German locomotives. Lately locomotives were built in the workshop of the Imperial Government Railways in Kobe, under the superintendence of Mr. R. F. Trevithick, who is the grandson of the great Trevithick, the famous locomotive builder.

Passenger cars and freight wagons are now built in the workshops of the Imperial Government Railways and several private railway companies. The Niphon Tetsudo Kwaisha, which is the largest railway company in Japan, is now building a large workshop in Omiya (16¾ miles from Tokyo) for the purpose of constructing locomotives, cars and wagons by the company's own hands. This railway company has sent locomotive and civil engineers to America and Europe to study railways in those countries. The Hiraoka Car Works, which were formerly in the compound of the military workshop in Koishikawa, Tokyo, have removed to the new workshop at Honjow in the same city, where cars and wagons are intended to be built extensively. From this firm also Mr. Hiraoka, Jr., who is the younger brother of the proprietor of the workshop, was sent to America in order to study car-building there.

Besides these, several famous capitalists in Japan are now planning to form a company for manufacturing railway rolling stock, of which the capital is said to be $500,000. The company is proposing to establish two workshops, one in Tokyo and the other in Osaka. As the labor in Japan is very cheap compared with America and Europe, the establishment of such a company will diminish the imports of railway rolling stock from other countries. Iron works are also going to be established by the Japanese government for the purpose of manufacturing this important engineering material on a large scale. But it will be some years before rails are made in Japan. The success of these schemes will check in no small degree the overflow of Japanese capital to the Western lands.

Thornycroft Water-Tube Boilers for the New Torpedo Boats.

Several of the torpedo boats and destroyers recently ordered by the United States Government will be supplied with Thornycroft water-tube boilers. The 30-knot destroyer for which the Union Iron Works has the contract is to have three of these boilers, aggregating 5,600 horse power. These will form an interesting installation, as each boiler will be of practically 2,000 horse power. The two 22½-knot boats to be built by Wolff & Zwicker will also have Thornycroft boilers; each boat will have two boilers aggregating 1,850 horse-power. The 20-knot boat building at the yard of Charles Hillman, in Philadelphia, will have two Thornycroft boilers aggregating 900 horse-power.

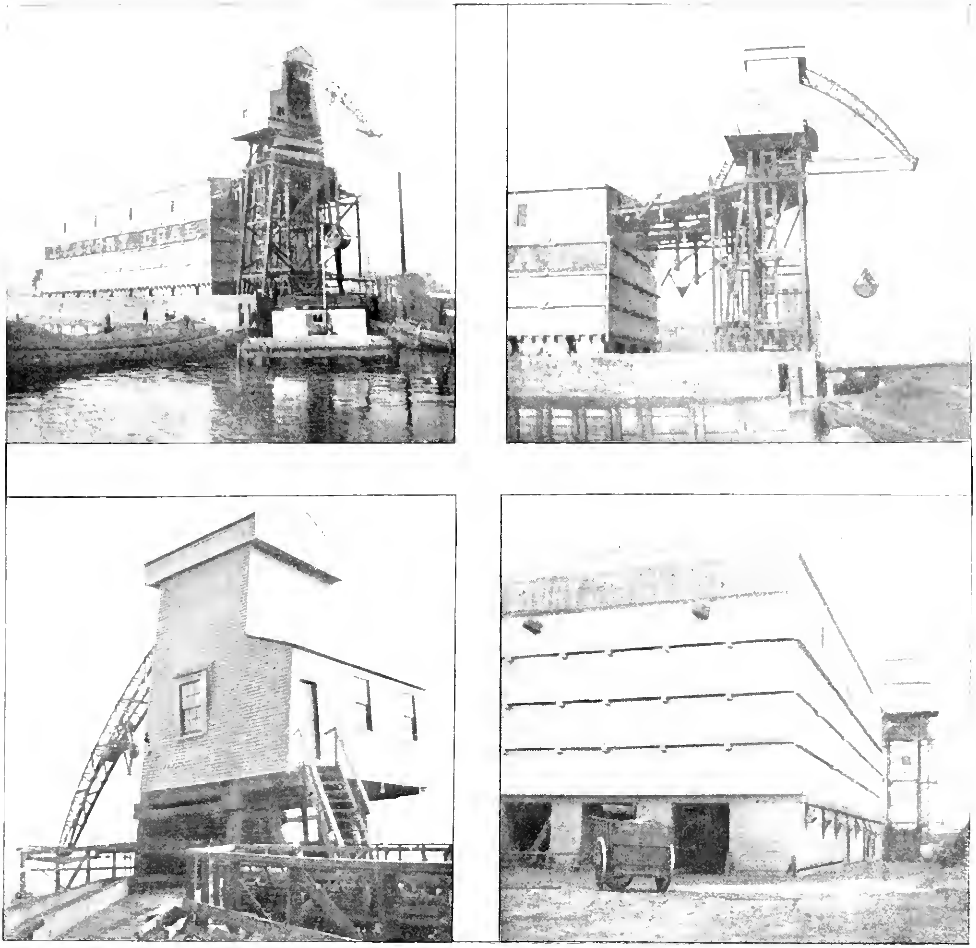
The manufacture of Thornycroft boilers in this country is controlled by Messrs. Thorpe, Platt, & Co., 97 Cedar street, New York. They are meeting with gratifying success in the introduction of the boilers here. The boilers have purposely been confined entirely to marine uses. In the offices of Thorpe, Platt & Co. there is a duplicate of the model boiler to which Mr. Thornycroft referred in one of his recent admirable papers on circulation in water-tube boilers. It is constructed with glass plates in the ends of the steam drum through which the workings of the boiler can be watched. It is fired with gas and can be started at a moment's notice. Those interested in water-tube boilers will find it instructive to watch this model at work, and it can be seen by them at any time at the office of these gentlemen.

Canadian Society of Civil Engineers.

The annual meeting for the election of the Council for 1897, and the transaction of other business, will be held in the Society's rooms, 112 Mansfield street, Montreal, on Tuesday, January 12, at 10 a. m. By the kindness of the Grand Trunk, Canadian Pacific and Intercolonial Railways, members and their families who shall have paid full one-way first-class fare going to the meeting, will be returned free. on presentation of a certificate signed by the ticket agent [from whom the certificate must be obtained] at the point of starting, and by the secretary of the Society.

Western Railroad Association.

On the 14th of November the offices of the Western Railroad Association in Chicago were removed to the Marquette Building, corner of Dearborn and Adams streets, Rooms 1327 to 1333, inclusive. All communications should be addressed to the Western R. R. Association, Room 1330, Marquette Building, Chicago, Ill.



Coal-Handling Plant for J. T. Story, Brooklyn, N. Y.—Fig. 1.
Built by the C. W. Hunt Company, New York.

Coal Handling Machinery at the Yard of J. T. Story Brooklyn, N. Y.—Built by the C. W. Hunt Company.

The cost of handling coal entirely by machinery is recognized to be so much less than by any of the old methods in which manual labor is employed wholly or in part, that the use of such machinery is rapidly increasing. One of the latest examples of a moderate size plant of this kind is the one recently completed for Mr. J. T. Story, of Brooklyn, by the C. W. Hunt Company, of New York. Mr. Story is a large dealer in coal in the city of Brooklyn, where he operates six large yards. The last addition to his facilities is located near the junction of Morgan and Johnson avenues and is on the bank of a canal branching from a creek opening into the East River. The coal is received in barges and both anthracite and bituminous coal are handled at this yard. The building in which it is stored is 135 feet long, 62 feet wide, and 50 feet high to the top of the bins. It contains 18 bins or pockets, each capable of holding 300 tons of coal without trimming or 350 tons if trimmers spread the coal after it is dumped from the cars. The total storage capacity is thus from 5,400 to 6,300 tons.

In Fig. 1 we have grouped four views of the plant, the first of which shows it as seen from the water side; the second is a side view of the hoisting tower, the third is a rear view of the top of the tower in which the hoisting engine is placed, and the fourth is the rear of the storage building. The method of handling the coal is to hoist it from the barges to the top of the tower by means of a two-ton steam shovel, where it is dumped into a hopper; from the latter it is discharged into the automatic cars which run on tracks on the platform extending from the tower to the building. The tracks are on a slight down grade, and the cars run into the building of their own weight, where they automatically dump their contents into the bins and return automatically to the hopper in the tower. From the bins the coal is drawn off into wagons through chutes at the bottom, that screens the coal as it is delivered to consumers. Thus at no point is the coal handled directly by men, and in getting it into the bins the number of men required is reduced to a minimum. The engineer in the tower controls all movements of the bucket, and two men are in charge of the cars carrying the coal to the bins. The boiler room is down on the ground, and of course requires the

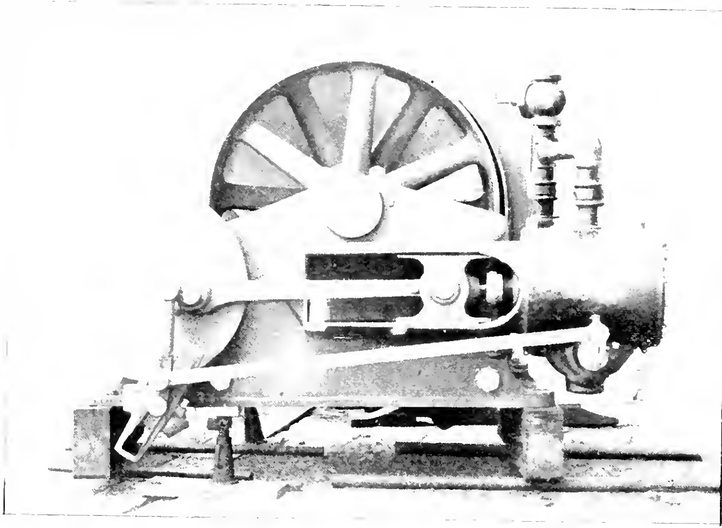


Fig. 2.

crank pin, while the other end is attached to the sliding block of a straight link carried on a tumbling shaft. The upper end of this connection has a circular motion, and the lower end moves in a straight line, the direction of which is dependent upon the link. The valve rod is attached to the connection at a point near its lower end, and the movement of the valve is largely derived from the horizontal component of the motion of the lower end. It is evident that throwing the link over to the opposite angle from that shown will reverse the direction of valve travel, and thereby reverse the engine. The valve is located under the cylinder, and is cylindrical in form. In this position it permits perfect drainage from the cylinder.

The hoisting and dumping chains are wound on the drum between the two sets of flanges seen near the gear wheel in Fig. 3. The chain winds up on itself, so to speak, and the change of diameter resulting therefrom is compensated for at the counter-weight drum seen on the nearer end of the same shaft. The counter-weight is suspended within the tower by a wire rope, one end of which is fixed while the other is attached to the drum. The counter-weight is sufficient to approximately balance the weight of the empty bucket and reduces the maximum demand on the engine during the operation of hoisting. The counter-weight cable unwinds on the increasing circumference of the drum and thus balances the weight of the steam shovel at all points. This arrangement gives the minimum steam consumption per ton of coal hoisted as the work of hoisting and lowering shovel is done by the counter-weight. The hoisting chain winds on a drum between the pair of flanges of the spool nearest the large gear. This drum is fixed on the shaft and between its flanges and the gear is a band brake by which the engine can be stopped. The next spool is for the dumping chain and is loose on the shaft, and is driven by a friction which is strong enough to keep the chain taut at all times. When the shovel is to be dumped another band brake on this spool (not visible on the engraving) holds the dumping chain, which is attached to the apex of the shovel frame, and when the engine is reversed the shovel opens.

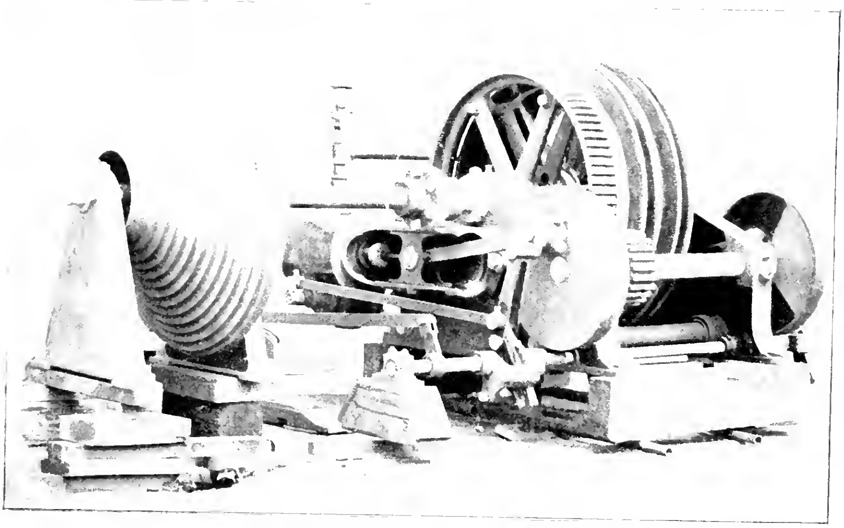


Fig. 3.—12 by 14 Inch Double Hoisting Engine.—Built by the C. W. Hunt Company, New York.

service of a fireman. Coal trimmers are needed in the barges only when the latter are so nearly unloaded that the coal cannot be reached by the steam shovel.

As already stated, the shovel has a capacity of two tons. It is operated by the double cylinder 12 by 14 inch hoisting engine in Figs. 2 and 3. The height to which the coal is lifted is about 75 feet, which is much greater than usual in this kind of a plant. The engine-room floor is 60 feet above the dock. The engine shaft is geared directly to the hoisting drum shaft, the whole arrangement being self-contained and compact. Several features of the engine are worthy of notice. The valve gear is one designed by Mr. C. W. Hunt, and is a modified Hackworth motion. It is very simple for a reversing gear, and consists of a connection, one end of which is carried on a return crank from the main

The shovel chains are of a novel construction which gives a

large bearing surface and great strength and safety. The links are each made up of a number of thin steel pieces stamped out of sheet steel. The chains pass over pulleys on a trolley that travels on the curved boom extended out from the front of the tower. When the shovel rises to the trolley, trolley and shovel travel together along the under side of the boom up into the tower where the contents are dumped into a hopper. In lowering, the trolley and shovel go out on the boom together until the trolley is arrested by a stop, after which the shovel decends vertically. The boom is fixed when the plant is in operation, but it can be swung to one side, allowing the masts of a vessel to pass it when necessary. This arrangement of engine and booms allows the hoisting plant to be operated by one man who has complete control of the engine and the shovel.

Fig. 4.

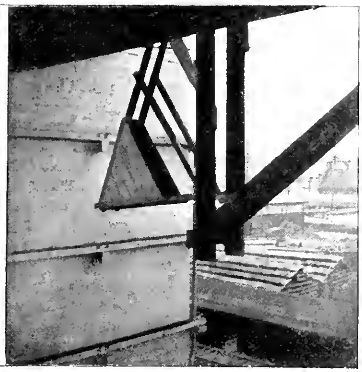


Fig. 5.

Weight Box for Automatic Cars.–C. W. Hunt Company.

The patented automatic cars used by C. W. Hunt Company in so many of their plants are probably familiar to a large number of our readers, but for the benefit of those not informed we will describe their operation. In this plant there are two narrow-gage tracks leading from the hoisting tower into the building, one track passing down each side of the building over the bins. There is one four-wheeled car for each track and the side doors of the cars swing on hinges at the top, and at this plant each holds a little more than a ton, so that one trip of each car delivers to the bins more than a ton of coal. Attached to the side side of one of the girders carrying the rails over the bins is a dumping block which strikes the latch mechanism of the cars as they pass: the side doors swing out and the coal falls in the bin. This dumping block can be shifted from one position to another so as to allow the car to dump in any desired pocket in the storage building.

The loaded cars run into the house by gravity, the tracks having just sufficient grade for this purpose. The mechanism by which they are returned automatically is ingenious and simple. Along each track are two wire ropes across which can be clamped a stop at any desired location. The loaded car as it goes down the track picks up this stop, takes it along with it, and draws the cable after it until its motion is arrested and its load is dumped. These cables are carried over pulleys to one corner of the weight box shown in Fig. 4, one upper corner being hinged to a fixed frame. These triangles, one for each track, are also to be seen in the second view of Fig. 1. When the car pulls the cable it lifts this box, which is heavily weighed, into the position shown in Fig. 5. As soon as the load is dumped the empty car is sent back to the loading point by the triangle as the latter returns to its normal position. Thus the dumping and return of the car are entirely automatic and by shifting the stop for the car and the dumping mechanism the car can be made to deposit its load in any desired bin.

A neat boiler-house has been erected on the dock and in it is a return tubular boiler 5½ feet by 16 feet, with 98 three-inch tubes It is rated at 100 horse-power.

There is a feature of the framing of the building and bins that deserves mention. It will be noticed from three views of Fig. 1 that on the outside there are four bands of heavy timbers. These are notched down over the ends of the timbers projecting through the sides, and all joints made so as to resist bulging under the weight of the coal in the bins. There are three passageways for coal teams under the bins and coal can be taken into wagons in any one of these passageways or from either side of the building. The chutes are operated from the wagon by the driver, and the trough of the chute has a bottom of netting through which the dust of the coal passes into dust bins located under the chutes.

This successful plant has a daily capacity of 600 to 700 tons of coal taken from the barge and delivered to the bins under normal working conditions: round trips of the bucket are frequently made by the engineer in 50 seconds, which, with a shovel holding two tons of coal, gives a maximum capacity greatly in excess of that amount.

The Construction and Condition of Mail Cars.

The annual report of the General Superintendent of the Railway Mail Service for the fiscal year ending June 30th, 1896, contains an interesting paragraph on the construction and condition of railway post-office cars. Statements received from all of the division superintendents show that the improvements made in car construction during the year covered by the report have been greater than for any similar period since the organization of the service. A large number of the railway post-office cars now in use are vestibuled, and in addition are provided with all modern improvements in the way of light, heat, couplings, buffers, etc. As a result, they pass through accidents more successfully than ever before, and the per cent. of the clerks killed and injured has been greatly reduced.

The report states that independent of improvements made in the construction of cars so as to increase their carrying and resisting power, the greatest improvement made has been in the character of the light. The total number of full railway post-office cars now in use is 778, all of which were formerly lighted by oil lamps, whereas at present 215, or 27 per cent., are lighted with Pintsch gas, which is regarded by the department as not only the best system for illuminating purposes, but also in the matter of the safety of the clerks and the mails in the event of accidents occurring to trains upon which clerks are assigned to duty. The number of cars heated by steam is 327, or 42 per cent. of the total.

An examination of the list of casualties contained in the report shows that while there has been a decrease in the number of instances in which mail matter was damaged by oil from the lamps, or actually destroyed by fire, resulting from this source or from the stoves, much annoyances and serious inconvenience is still caused by these troubles. There are 32 cases cited in which mail matter was damaged by oil from the lamps, three cases in which fire originated from the oil lamps, eight from the stoves and eight from causes not definitely known.

It is very gratifying to note that the Railway Mail Service Department has received the hearty co-operation of all important railway lines in the work of extending the application of safety devices to the mail cars, and that quite a number of companies who have not up to the present seen their way clear to the introduction of Pintsch gas, steam-heat, vestibules and other safety appliances are carefully considering the matter, many of them having determined to adopt these features at an early date. Since the safe transportation of the mails is of such vital importance to the business interests of the country, it is to be hoped that the work of strengthening and improving the mail cars will be rapidly carried forward, and that on the records of another year there will be fewer cases of loss of life to the clerks and of destruction or damage to the mails than ever before.

(Established 1832.)

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

28TH YEAR. 66TH YEAR.

PUBLISHED MONTHLY
BY
R. M. VAN ARSDALE,
MORSE BUILDING..NEW YORK.

M. N. FORNEY, W. H. MARSHALL, } Editors.

R. G. CHASE, 705 Western Union Building, Chicago.

JANUARY, 1897.

Subscription.—*$2.00 a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union.*

EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Special Notice.—*As the* AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL *is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 25th day of each month.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* **When a subscriber changes his address** *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

The paper may be obtained and subscriptions for it sent to the following agencies: **Chicago,** *Post Office News Co., 217 Dearborn Street.* **London, Eng.,** *Sampson Low, Marston & Co., Limited St. Dunstan's House, Fetter Lane, E. C.*

By the reversal of the decision of the Circuit Court in the St. Louis coupler suit, the right of steel and malleable iron companies to supply parts of couplers to railroads for repairs appears to be established. The only limitations are that the parts supplied shall not amount to a reconstruction of the coupler and that the part or parts furnished shall not be patented articles in themselves. In other words, though the replacement of a knuckle does not constitute reconstruction it can only be supplied when the patents do not claim the knuckle separately but only in combination with other parts; furthermore such knuckles must actually be used for repairs, and cannot be used with new heads or locks supplied by the same or other parties without constituting infringement.

Our readers may be interested to know that the decimal gage adopted by the Master Mechanics' Association, American Society of Mechanical Engineers, and several other societies, is receiving substantial recognition. Recently the American Steel Manufacturers Association adopted it and will hereafter use it to the exclusion of other gages. Several large railroads, notably the Pennsylvania and Southern Pacific have issued orders from the General Manager's offices that no other gage be used in the ordering of material. The Pratt & Whitney Company have completed 500 of these gages and are at work on the second 500. The tools for making the gages have been expensive and have required much skill in their design and construction. The greatest problem presented was due to the elliptical form of the gage and consisted in milling each of the slots in the circumference of the gage normal to the curve. But this and other problems have been solved satisfactorily and the gages will now be turned out with greater rapidity. Added to the undoubted merit of the decimal gage, the anxiety displayed in many quarters to obtain gages at an early date augers well for its general adoption and the ultimate abandonment of the divers gages now in use.

Last month we referred to the movement inaugurated by the Ohio Falls Car Manufacturing Company for the establishment of a standard box car incorporating the Master Car Builders' standards and recommended practices, this standard to be followed by the various car-building concerns when filling orders for small roads who do not furnish drawings or standards of their own. A communication on this subject to the Central Railroad Club met with a queer reception. It was laid on the table because it was considered to be an attempt to "anticipate the functions of the Master Car Builders' Association." The gentlemen who expressed this opinion ought to know better, and we must conclude that the project was not carefully considered by them, or such action would not have been taken. It is true, as stated, that the Master Car Builders "have been adopting standards for a great many years, and they have not designated all the standard parts of a freight car or its capacity," but that should not stand in the way of manufacturers undertaking to put the standards already adopted into more general use or to uniformly employ certain leading dimensions, not yet standardized, in their own practice. The plan rightly carried out has everything in its favor and is deserving of hearty support, and we cannot see how the dignity of the Master Car Builders' Association is going to suffer by it or its prerogatives be usurped. The circular letter which we received certainly gave due prominence to the work already accomplished by the association and made provision for a prompt recognition of anything it might do in the future. We are still of the opinion that the movement is a good one and we wish it complete success.

In 1897 those attending both the Master Car Builders' and Master Mechanics' conventions will be compelled to stay at Old Point Comfort for at least 10 days, or the longest of the periods over which the two conventions have been spread in recent years. Many times have the associations been urged to curtail the interval between the two conventions and a few years ago the sentiment in favor of it was so strong that it was expected a permanent change would result. The time was shortened in 1891 to six days, but since then change after change has been made and through it all the period has been growing steadily, as will be seen when we state that from 1890 to 1896 inclusive, the days occupied by the conventions have been ten, six, eight, nine, nine, nine and eight respectively, and in 1897 the number will be ten. These figures indicate a vacillating policy that is not particularly creditable, and the manner in which the by-laws relating to the date of the conventions have been changed seems to be free from all deliberation or serious thought. Quite a number of the members of both associations, men whose opinions we all respect, believe that unnecessary time lost between conventions is an injury to the associations, as it prevents many prominent railroad men from attending both conventions. If, instead of continuing to pursue the vacillating policy of the past the associations would next June appoint a joint committee to recommend some fixed programme for the two conventions and at the same time suggest such changes in the order of business, or amendments to the constitution and by-laws as will expedite the routine business, the two conventions can not only be held in much less time than ten days, but more and better work will be done in the shorter period than is now accomplished. If only two days out of ten are saved the result will be welcomed by many. With an average attendance of 1,200, the total saving in time would be 2,400 days or the equivalent of seven years of one man's time. If out of the

1,200 there are only 300 who are anxious to save time, it ought to be remembered that many of these 300 are men who are doing the best work in the associations, and whose roads have indirectly at least contributed much to the advancement of the societies through the experiments and investigations carried out on their lines and at their expense.

Besides the reduction of the time occupied by the routine business of the associations, another reform, needed more particularly in the Master Mechanics' Association, is the selection of better subjects for committee work. Just how this is to be brought about is not so important, but that better subjects are required is a settled conviction not only in our own minds but in those of several prominent members who have expressed their opinions to us. When the association investigates and takes action on such matters as a decimal gage, standard dimensions of tires, boiler steel and tube specifications, locomotive tests, proportions of exhaust pipes and nozzles, and others which might be mentioned, it usually does most creditable work—work that is appreciated not only in this country but abroad—but when it receives committee reports on petty details which could better be taken up in carefully prepared topical discussions, it detracts from its own dignity. Many of these reports on details of locomotive construction have been excellent and yet the committees reporting on them must have often felt that they were small matters on which to elaborate a formal report. These same committee men could have started valuable topical discussions on the details assigned them, without feeling that they were called upon to handle a small matter in a large way. It may not be easy to formulate a satisfactory rule for guidance in the selection of subjects for reports, but possibly as good a one as any would be to call for reports only on those subjects which, because of their general character or the time and expense required for their investigation, or for other good reasons, cannot be studied by each road individually, and to assign for topical discussion subjects less broad, and which most roads can investigate in part for themselves, or on which they can gain some experience in the course of regular operation.

There are excellent prospects of an extensive addition in the near future to the world's experience and knowledge of the merits of water-tube boilers for all kinds of marine purposes. Much of this added experience will be derived from the navies of various nations, for at the present the installations of water-tube boilers on naval vessels range from those on small torpedo boats to the 25,000 horse-power in the British cruiser *Powerful*, and include a number of the prominent and successful types. In the size of the individual boilers installed there is also a wide range, the largest running into thousands of horse-power. In the merchant service there are many modern vessels fitted with water-tube boilers, some of them running along our Atlantic coast, others on the great lakes, while British and Continental yards have fitted ocean-going steamers with these boilers. There is of necessity a great difference in the construction of water-tube boilers for cruisers and for that class of vessels of which the destroyers head the list. Boilers for the latter must be of the lightest possible construction, and produce the maximum of horse power from the minimum of space. The result of these demands has been the production of boilers that exhibit the highest engineering skill, but are of a lighter construction than would be desirable for large merchant vessels. The boilers in large cruisers need not be extremely light, and in all respects they approach more nearly to what would be required for large ocean steamers. For this reason the merchant marine, while watching with interest the performance of all water tube boilers in the navies of the world, will be specially interested in the boilers of these large men-of-war. The experience gained from them, added to the records obtainable from the merchant vessels similarly equipped, will in a few years provide much valuable information for the guidance of those concerned in the construction and operation of large steamers. And it will not be surprising if in the same period the merits of the water-tube boiler should bring them into extensive use for small steamers, yachts, and craft other than ocean-going steamers.

THE ENGINEER IN NAVAL WARFARE.

The December number of the *North American Review* contains a symposium on "The Engineer in Naval Warfare," the several articles of which have been written by Rear Admiral J. G. Walker, Captain A. T. Mahan, Captain R. D. Evans, and Lieut. S. A. Stanton, all of the United States Navy. These officers have submitted their various contributions as the substantial argument of the line branch against increasing the number and improving the status of the Naval Engineer Corps. One would be justified in expecting from such officials a dignified and pertinent discussion of the long existing controversy between the sailors and the engineers of our navy; but the real issues of the struggle have only been lightly touched upon, and the several contributors seem to have made a concerted effort to imply that the naval engineers desire command of the vessels, and seek honors to which they are not entitled. It is a significant fact, one that testifies to the weakness of the position of the line in this controversy, that in all their contributions to the discussion of it only two arguments--if they can be called arguments--have been advanced; the first charges the engineer with an attempt to get command of more than his department--a charge that has repeatedly been shown to be false; the second takes the form of strenuous pleas for the maintenance of "military organization" without a single definite statement of how that military organization is endangered by the proposed reforms. The symposium in the *North American Review* is only a reiteration of these charges and specious pleadings.

SPECIOUS PLEA OF THE LINE.

Except the dignified discussion of Captain Mahan, the tone of all the articles is narrow and unpleasant, and will tend to give the country a less exalted opinion of the men who practically control our naval organization. Captain Mahan attempts to handle this subject through the same processes of reasoning and statement which have made his style of writing famous. The claims of the naval engineers, however, are of too practical a nature and too deeply concern the usefulness of the service for even Captain Mahan to controvert by specious pleas and attractive charm of diction. Like all the other contributors to the symposium, Captain Mahan is exceedingly anxious that military titles shall be withheld from the engineers.

Rear-Admiral Walker practically commences his article by declaring that he "has not taken part in the so-called Line and Staff controversy." The press dispatches of the past 20 years show that the Admiral has been a recognized leader of the line forces, and has appeared before successive Congressional committees as the leading representative of that faction. There may be a question in the minds of many people as to whether even an Admiral with a memory so faulty in regard to his own acts is competent to discuss broadly a problem involving important matters in the lives of others. A man with such a distressing infirmity is liable to make serious mistakes, and in this case that fact doubtless explains why the Admiral has made many surprising statements. He charges the naval engineers with proclaiming "that engineering is now the leading science, and the care and management of steam machinery the leading art, of naval warfare"—a declaration that has never been made by the engineers, and which the Admiral ought to know does not represent the views of the engineers.

The Admiral then pleasantly reviews his career of 46 years in the navy, and does not fail to remind us that he has "reached the highest rank in the navy"; that part of his extensive experience has been gained "as Admiral in command of a fleet," and that he has rounded out his education by a study of foreign naval systems. Having given his readers this gratifying information, so germane to a discussion of this kind, he indulges in truisms and platitudes concerning the necessity of military discipline and training that are disputed by no one. He tells us that "a navy exists for war alone"; that "it is essentially a military organization in time of war," and should be one in time of peace; that military training and military knowledge are of importance, etc., etc. All of this is very, very evident, even to a civilian, but where does it touch on the rights of engineers, or on the

present controversy? The civilian expert knows the value of training and discipline. He also knows what the Admiral apparently does not (perhaps he has forgotten it)—that the success and efficiency of any extensive organization depends in great measure upon the maner in which each and every man is made to feel that he is an essential part of it. In attempting to belittle the work of the engineer, and in ridiculing his claim to official recognition, the Admiral does much to make the engineer officer even more discontented than he has been in the past. He also does much to destroy that very discipline which he prates so perfunctorily about.

Can the Admiral do anything more to foster the discontent already existing? Can any one be blind to the studied insult of such statements as: "In the business of warfare the men who direct the operations of war and handle the weapons of war are those upon whom the success of war depends"; and "the duties of those who do not take a distinctly military part, while necessary and important, are adjunct and essentially subordinate." Are these statements even true? The *Engineer*, a great English journal, than which there is none more capable of intelligently discussing naval matters, says in its issue of Feb. 7, 1896: "The truth will have to be recognized that without the engineer, the admiral, the captain, the blue-jacket, the whole executive branch of the service are useless. The naval supremacy of Great Britain *rests in the hands of the engineers*. . . Mr. Goshen must take steps to add to the number of engineers." And our contemporary distinctly says in another part of the article quoted that it is not engine drivers, not even merchant marine engineers, but specially trained and educated naval engineers that it is talking about.

Admiral Walker writes as though he had unanimous opinions of naval experts to back him up, whereas on every hand, in the service and out of it, in this country and abroad, we can find men who are positive that the duties of the engineers are now among the most important factors in naval operations.

HOSTILE AND BITTER ATTITUDE OF THE LINE.

The contribution by Capt. R. D. Evans opens with a slur upon Engineer-in-Chief Melville, whom the engineering world recognizes as in many respects the most distinguished man in the naval service. This is followed by a charge of inefficiency of the engineering force in general, and a magnificent tribute to his own achievements when in command successively of three of our modern ships. His article covers six pages, of which two are devoted to what he accomplished as commander of the *Yorktown*, *New York* and *Indiana*. If we are to take him seriously, the only drawback to still greater achievements by him was the faultiness of our naval machinery and the incapacity and insubordination of the engineer's division detailed to his ships. He furnishes nothing worthy of discussion, but in his closing paragraphs he tells the country that the engineer is too much of a luxury on board ship and that is wanted in the engine-rooms are uneducated engine drivers. He would reduce the number of engineers and take into the service a corps of warranted machinists. Captain Evans was Admiral Walker's Fleet Captain, and therefore, like his chief, the prejudiced captain, indulges in slurs upon the Engineer Officers and their force of men. When the men below the protective deck are told that they may die in defense of the flag of their nation—because they are paid for it—they need no further evidence of the injustice practised against them.

What are we to think of a captain who points out the discontent that exists in a branch of the service, and then deliberately attempts to impress upon the men in that branch the belief that they have no share in the honors of war, in fact that they are only tolerated in the navy because there is some machinery on board our vessels which the line officers do not understand, and which they must therefore have men paid to operate?

The first sentence of Lieutenant Staunton's composition is characteristic of its general tenor. He commences as follows: "Two ideas are assiduously advanced by the engineers; first, that they are the sole inheritors afloat of the genius of Watt and his fellow-pioneers in modern science and mechanism," etc. Such an unreasonable and untruthful assertion shows that this subordinate officer has contributed nothing of genuine value to the discussion. He states that "under their (the line officers) sole direction and guidance has been developed the manufacture of steel—the manufacture of armor which has led the world." He thus claims for the line officers credit which is justly due to the great manufacturers of the nation. Cast steel, structural steel and armor plate, torpedoes, projectiles and the rough forging for guns have been furnished entirely by private parties. The most prominent way in which line officers of the navy have figured in the steel industry has been the incompetent and disgraceful manner in which they have looked out for the interest of the government when acting as inspectors. If they had not attempted to usurp the duties of the naval engineers and naval constructors in the inspection of steel, the country would not have been humiliated by the armor fraud scandal, nor by such exhibitions of incapacity as is revealed in the press of last month, relative to material furnished for some of our vessels under construction.

OUR INEFFICIENT NAVAL ORDNANCE DEPARTMENT.

The manufacture of guns has been chiefly in the hands of the line officers. This policy has not been productive of good results, for while the largest rapid-fire guns in our navy are six-inch (and there are only a few of them), other navies are mounting rapid-fire guns up to and including eight inches. Other nations are obtaining greater muzzle velocities for nearly all calibers than are derived in our own practice. Other navies have developed wire-wound guns by which greater strength, less weight and ultimately less cost and time required for manufacture are attained. Our navy has done nothing in this respect—the army is experimenting with such a weapon. We do not say this in a spirit of reflection on our ordnance officers. We all know that private firms, with their facilities for experiment, and with some government encouragement, can always outstrip the governmental shops. Our ordnance will continue to be inferior to that of other nations until private firms in the United States manufacture heavy guns like Armstrong does at Elswick, Krupp at Essen, and Canet at Havre.

OUR INADEQUATE NAVAL ENGINEER CORPS.

If anything further is needed to show the unreliable character of Lieutenant Staunton's article it can be found in his comparison of of the engineers of the British and American navies based upon the number of ships possessed by each nation. The numbers are valueless without a statement of the character of the vessels that compose the table. He knows, although his readers do not, that the English list includes yachts, store, surveying, sailing, training and harbor ships. He also knows that it includes 150 vessels laid up in reserve. Furthermore he says not a word about the number of engineers in the British navy being too small for the ships in commission. It is a fact nevertheless. *The Engineer*, Feb. 7, 1896, says: "We beg our readers to turn to the *Engineer* of March 8, 1895. In it they will find an elaborate setting forth of the Admiralty distribution of engineers in the fleet. . . . The principal fact is that last March there were 318 engineers needed and only 85 available. . . . We have not engineers enough for the ships we now have; whence are they to be had for the large additions that must be made to our fleet?" Lieut. Staunton has not told his readers that in the report of the Secretary of the Navy Mr. Herbert officially states that the United States possesses 73 ships, while Great Britian has 493. Nor does he state that there are 1760 commissioned line officers in the British service, and 723 in the United States navy, in other words that the United States has 9.9 line officers per ship, while in the English service there are only 3.52 officers per ship. It is incredible that men belonging to a profession wherein the standard of honor has always been regarded of high order should half tell the truth as Lieutenant Staunton has done.

Based upon such false and misleading tables, all the contributors, with the exception of Captain Mahan, demand that the number of engineers should be reduced. Their views are not in accord with the experience and study of the honorable secretary of the navy, for in Mr. Herbert's annual report to the President, page 43, he urges the augmentation of the Corps of Naval Engineers "until the limit shall be 250 instead of 194 as at present."

OFFICIAL RELATION OF THE CHIEF ENGINEER TO THE COMMANDING OFFICER.

Captain Mahan's article is the only one of the four that is wisely tolerant of the views of the engineer. His whole argument is a defense of the military organization on board ship. He shows that the line is naturally the directive power, and as such must command. Its position above the protective deck in contradistinction to the location of the engineers below that structure places the power of command with the line branch. Captain Mahan declares that the engineer "recognizes the captain. but resents the executive officer and the officer of the watch. The spirit, however, is one." Does Captain Mahan contend that in the army there can be a trinity composed of the commander of the post, the adjutant of the battalion, and the officer of the day, all vested with authority to assume at will to direct the administration of the garrison? Is not the directive power concentrated in the senior line officer present?

Of course the naval engineers resent the claim that a trinity of men on board ship can each assume command prerogatives. The engineers acknowledge that the succession to command is lodged in the line officers, but they do maintain that the inheritance cannot be assumed by anyone so long as the captain is on board ship and fit for duty. The representative of the captain will be implicitly obeyed in any order that he may convey, but such a messenger cannot assume other command prerogatives. In the controversy which has resulted there has never been a hint from the engineer against the authority of the commanding officer, or the prompt obedience to a signal from the bridge, even if that signal be made by a powder boy. Sections 10 and 17 of the Wilson Engineering and Educational bill, which is in full accord with the views of the engineers, prove the sincerity of their unqualified recognition of the commander as the supreme authority.

It is not the desire of the engineers to command ships. They are striving to command the men of their own department, subject alone to the authority of the commanding officer. They demand that they shall be placed upon an equality with officers of the line in performing their duty.

NECESSITY FOR TRAINED ENGINEER OFFICERS ON BOARD SHIP.

With the exception of Captain Mahan—and even he implies the thought—the several contributors maintain that the engineer officer is virtually an engine-driver when he goes on board a warship. It will surprise the engineering world to be told that the expert in charge of the complicated machinery of modern ships of war is thus regarded by the commanding officers of the American Navy. It must be a trained mind which is able to superintend the efficient working of machinery costing over one and one-half million dollars. The line officers insist that the small amount of machinery in their charge should be under the administration of technically educated line officers with titles and rank that are genuine, but they urge that all the remainder of a vessel's machinery, including its great propelling engines and its boilers, together with all the men needed in their operation, shall be taken from the care of highly-educated engineers and shall be placed in the keeping of uneducated engine-drivers without title, rank or authority.

There are men in the Congress of the United States who would take good care that no more money should be appropriated for ships-of-war if the care of the machinery was to be intrusted to engine-drivers and not to highly trained experts. The progressive and excessive cost of repairs to our warships can be easily accounted for, if all the commanders of our vessels hold such views. Demoralization and discontent must reign supreme if our naval commanders accord such a status to the engineer officers.

Without going further into this controversy, we find the situation as follows: The country has thus far acted on the assumption that educated engineers are needed on our modern warships. To secure such men they have been educated at Annapolis at a a cost of $15,000 per graduate. To retain such experts when it does secure them, it must make the engineer's positions on shipboard more tolerable than the existing organization provides. The engineer's duties are chiefly those of superintendence in their department, and the executive duties belonging to it, and their authority should be sufficient to free them and their men from unnecessary petty annoyances. Having placed engineers of education and high attainments on board our ships, must it now be confessed that it is impossible to accord them the status of officers? Must the efficiency of their department be sacrificed in order that the traditional customs of the service be preserved? A large and efficient force of engine-drivers must be secured. but their work can only be satisfactorily performed under the guidance and direction of a trained corps of educated and scientific experts.

RANKS AND TITLE IN OUR NAVAL ORGANIZATION.

The staff of the navy demand to be placed on an equality with the staff of the army. The naval engineer is entitled to official recognition and military titles should not be withheld from them. Title simply designates and unqualifiedly acknowledges rank. The line of the navy has attempted to use it as a patent of official superiority and as a license for privilege. The coddling of one set of officers, as regards pay, rank, title, position, power, privileges, to the neglect of other officers whose duties are in many respects as important, is a certain way of securing inferior talent and character. It invites defeat in the issue of battle, for which alone navies exist. The good of the commonwealth should be the sole consideration, against which naval traditions, usages, jealousies, and the desire to obtain all the advantages, prestige and emoluments of the naval service, should be urged in vain. This favoritism to the line can only be secured by a corresponding injury to the navy as a national weapon.

DEFECTS AND IMPROVEMENTS IN LOCOMOTIVES.

In the first article on this subject, which was published in the September number, reference was made to steam superheaters as a means of saving and utilizing some of the heat which now escapes up the chimneys of locomotives. The economy which is possible by superheating steam, like that resulting from heating the feed-water, has long been known, and innumerable experiments have been made and appliances devised for securing the economy which would be available if the practical difficulties could be overcome. Heretofore these have been chiefly due to the high temperature of the steam, and the consequent destruction of the lubricating material by the hot steam. This trouble could be assigned to three causes: first, to the difficulty of regulating the temperature of the steam; second, to the use of vegetable packing, and, third, to the fact that the animal oils, used for lubrication before mineral oils were generally introduced, were disentegrated or decomposed at comparatively low temperatures. Recently, renewed attention has been given to this subject, especially on the continent of Europe. Some of the mineral oils, as is well known, will stand a much higher degree of heat than the old animal lubricants would, and the same thing is true of metallic packing compared with that formed of hemp and other similar materials. Steam of a higher temperature may therefore be used now than was possible when the cylinders and valves were lubricated with animal oils. The problem, too, has been attacked from the other end, that is by providing means for regulating the temperature of the steam after it is superheated and preventing it from entering the cylinders at an excessively high degree of heat. The methods of this will be discussed farther on.

The difficulties of superheating may be understood if it is realized that a modern express engine, running at the rate of 60 miles per hour, cutting off at one-third of the stroke, uses about 1,260 cubic feet of steam per mile and per minute, or 21 cubic feet per second. A given volume of steam, it must be remembered, will not absorb heat as rapidly as the same volume of water will. The sensible temperature of steam of 170 pounds pressure is 375 degrees and it also contains 852 degrees of latent heat, or heat of gasification, as some have called it. The specific heat of steam is less than half that of water, or, in other words, it will take less than half as much heat to raise the temperature of a given weight, say a pound, of steam one degree as would be required to heat a pound of water one degree. For each degree that dry steam is superheated its pressure is increased .00236, or for each 100 degrees its pressure will be increased .236 and 200 degrees .472.

That is, dry saturated steam of 170 pounds pressure if super-

heated 110 degrees, would be increased to 210 pounds pressure, and if superheated 200 degrees its pressure would be 250 pounds. But the total heat in a pound of saturated steam is 1,227 units. As it takes less than half as much heat to raise the temperature of steam a given number of degrees, as is required to heat water to the same extent, it will be seen that somewhat less than 50 units of heat will increase the temperature of a pound of steam above 100 degrees, and its pressure 40 pounds, and 200 units will add 100 degrees to the heat and 80 pounds to the pressure. That is an addition of 8.15 per cent. of heat increases the pressure 23½ per cent., and the addition of 16.3 per cent. of heat increases the pressure 47 per cent. It is not pretended that these figures cover the whole theory of superheating, but they indicate the source of its economy.

Now that this theoretical saving is, at least in part, realizable in practice, has often been shown, but especially in recent experiments made with stationary engines in Switzerland and Germany. Thus the *Bulletin de la Societe Industrielle de Mulhouse*, for April-May, 1896, reports that a compound engine was tested in Alsace recently, in which the mean steam pressure was 5.7 atmosphere (85.5 pounds), with the following results:

Steam Superheated.	Economy of coal.
167.6° F.	8 per cent.
183.2° F.	14.4 per cent.
212° F.	20 per cent.

That is, the figures in the first instance indicate that in that experiment about one-half the theoretical economy indicated by our figures was actually realized in coal consumption, and in the last about two-thirds. There must of course be a counter charge against this saving for the first cost and maintenance of the super-heating apparatus, and all experience teaches that this may consume all the saving, and more too, but the problem which it is intended to present here is the practicability of devising an apparatus which will effect this economy without a cost which will make it unprofitable. There can be no doubt that such an economy is possible ; the only question is whether it can be effected without costing more than it is worth.

At any rate it will be worth while to consider what must be done, and the means required to do it, in order to superheat the steam consumed by a modern express engine, which uses 1,260 cubic feet of steam of 170 pounds pressure per minute. The weight of a cubic foot of steam, of that pressure, is .4142 pound, so that we have a total of 521.8 pounds of steam to be superheated per minute. As it takes somewhat less than a half a unit of heat to superheat each pound of steam one degree, we must be prepared to transmit about 25,000 units of heat per minute from the products of combustion to the steam to superheat it 100 degrees or 50,000 units to heat it 200 degrees. Unfortunately our information and knowledge of the laws governing the transmission of heat to steam are not very exact or reliable. A locomotive of the kind which has here been taken as an illustration would have about 1,800 square feet of heating surface, and it consumes 521.8 pounds of steam per minute and must of course convert that quantity of water into steam. The total heat in this steam is equal to about 600,000 units, so that about 333 units of heat must be transmitted to the water per square foot of heating surface per minute. When a locomotive is working hard the fire in the firebox has a dazzling white appearance, the temperature of which is about 2,800° F. At the same time the products of combustion escape into the smokebox at a temperature of about 800 degrees. If we take a mean of the difference or 1,000 degrees and add it to the smokebox temperature we will have 1,800 degrees as the average temperature at the heating surfaces in the boiler of the locomotive. As the water and steam in the boiler have a sensible temperature of 375 degrees the difference between the heat on the fire side and that on the wet transmitting surfaces, would be equal to 1,800 — 375 = 1,425 degrees. Consequently on these hypotheses about one quarter of a unit of heat is transmitted per square foot of heating surface per minute per degree of difference of temperature. Taking the smoke-box temperature at 800 degrees and that of the steam to be superheated at 375 degrees and the same rate of transmission per degree per square foot per minute in a superheater that has been calculated for the boiler and we would have a transmission of a little over 100 units of heat per minute.

To increase the temperature of the steam 200 degrees it has shown will require the transmission of about 50,000 units of heat per minute, so that our superheater must have about 500 square feet of surface. Now, it must be admitted that it will not be easy to provide that amount of heating surface in the smoke-box of a locomotive, which seems to be the only available location for it. Then it also seems certain that the rate of transmission of heat from the products of combustion in one side of a plate or a tube to steam in the other will be slower than it is if the medium through which the heat must pass is in contact with water; in fact the rate of transmission of heat in a superheater is given by Longridge at only one-twelfth of a unit per square foot of surface per minute per degree of difference of temperature. If this is correct a much larger amount of heating surface will be required in a superheater for the transmission of a given amount of heat than is needed in a boiler.

Nw these difficulties are pointed out not for the purpose of proving that the problem is insoluble, and that an effective superheater for locomotives is impracticable, but for the purpose of showing the difficulties which must be overcome. Unfortunately, too, in addition to these, there are some others. If the amount of heating surface which is required in the superheater is provided, one of two things is liable to occur when steam is shut off. If the superheater is then filled with steam it is liable to be treated to a very high temperature, while it is quiescent in the heater. If the throttle valve is so arranged that when steam is shut off from the engine it is also shut off from the superheater, the latter will then become heated to a high temperature, so that the first steam which the passes through thereafter will be liable to be overheated. As was pointed out at the beginning of this article, the regulation of the temperature of superheated steam has always been a difficulty in using it. Two methods of overcoming this difficulty have been suggested and employed, one to carry the hot steam after it has been superheated through pipes in the steam space in the boiler, so that any excessive heat is imparted to the steam in the boiler outside of the pipes. Of course, what may be called the superheat in the steam inside of the pipes would never all be imparted to the saturated steam outside of them. The hot steam would always retain some of its superheat, but the higher its temperature the greater would be the rate of transmission from the steam inside to that outside of the pipes. In this way any excessive heat would be imparted to that in the boiler the temperature of which could never get above that of saturated steam of boiler pressure.

Another method of tempering the heat of superheated steam is to first use it as a steam-jacket around the cylinders, by which any excessive heat would be absorbed. It has been shown that each of these two methods has been very effective in stationary engines, and there is no theoretical reason why they are not equally applicable to locomotives. The difficulties are all of a practical character—that is, to find room for the heating surfaces required and designing and constructing them in such a way that they will not be liable to fail at critical times or cost too much, or require expenses of maintenance which will absorb all the saving of fuel. There can be no question, however, that a theoretical saving of from 10 to 20 per cent. is possible by the use of superheated steam. This, and more, too, has been realized in practice. It is given at from 10 to 50 per cent. by Professor Thurston in his paper on superheated steam, read before the St. Louis meeting of the Mechanical Engineers last May. He also quotes from Mr. Donkin, than whom there is no better authority, who said that "no possible improvement of the steam-engine, of which we have any knowledge at this moment, offers anything like so great a chance of important economy as the introduction of superheating, and especially of superheating to at least 100 degrees or more above the saturation temperature of the steam."

The only question is the cost of effecting such economy. To persons of an ingenious turn of mind, with plenty of experience, and having besides what may be called *iron horse* sense, it is an inviting field for the exercise of invention.

Any one attacking this or any other problem in locomotive improvement should remember, though, that success here, as elsewhere in this field, will always be subordinated to the fact that the chief end of a locomotive is to haul trains, and not save fuel or make good indicator diagrams. Primarily it must haul its train without delay or interruption. If it can do this, and save coal and make good indicator diagrams at the same time, so much better, but if a railroad manager must choose between a locomotive which can haul its trains regularly and promptly, and yet is wasteful of fuel, and makes indicator diagrams resembling an old pair of boots very much down at the heel, or one which must be laid up for repairs from time to time, although it is as economical of fuel as a miser is of money, and whose indicator diagrams would delight the heart of a professor of engineering in a technical college, the railroad manager is sure to prefer the more reliable although more expensive machine.

THE TRAINING WHICH APPRENTICES NEED.

The report on apprentices presented to the Master Mechanics' Association last June has apparently been the means of directing attention to the education of young men in our railroad shops, and several papers and discussions before technical societies and railroad clubs attest the genuineness of the interest displayed. A peculiarity of much that has been suggested for the improvement of the apprentice is that it follows the lines of a more or less thorough technical training. The plans seem to be put forth with the belief that the present shop training is satisfactory, or that the technical training proposed will correct its shortcomings. The spirit in which these suggestions are made is most worthy, for, though some things done for apprentices may yield a good financial return, such educational schemes as have been outlined call for an outlay by the employer from which others will often reap the benefit.

Recognizing this excellent spirit of helpfulness toward apprentices, we nevertheless cannot agree with those who propose the educational courses outside of the shop work proper as the first step to be taken. As long as shop training is what it is at present, an offer of technical education to the average apprentice is like giving him a stone when he asks for bread. The stone may in this case be offered in good faith, but his digestive organs are not capable of dealing with it, nor is it the kind of food he craves. What he wants first, and what he has a right to expect, is to be taught those things necessary to proficiency in the trade he has selected. If he has ambitions to become more than a mere journeyman that is his affair, and he may generally be counted upon to fulfill those ambitions without direct help from his employer, though assistance from that source, if given, may be gratefully appreciated and will reflect credit on the giver. But the shop training is something which his employer has *contracted* to furnish him. His pay as an apprentice is to consist of two things—a course of instruction in the trade he has chosen and a small sum of money, made small because of the expense, direct and indirect, incurred by the employer in providing the instruction. Now the first question to be answered in any case before further training is considered is, "Does the employer faithfully discharge the obligations he is already under to his apprentices?" Is he giving them a proper shop training?" In how many shops can these questions be answered in the affirmative? Not many, we fear.

In a recent discussion of this subject before the Western Railway Club, Mr. Wm. Forsyth, Mechanical Engineer of the C., B. & Q. R. R., made an excellent plea for the apprentice when he said:

"They (those advocating a technical training) have gone beyond the practical training of the apprentice, and they have undertaken to set up a technical school in our railroad shops. I do not believe that this is the first thing to do. I do not believe it is the most important thing to do, for I think that nearly every railroad shop has in its superintendent of motive power and in its foreman the opportunity to do a good work for the apprentice boy, but they are shirking it, they are avoiding it. When I was learning my trade I was given an old lathe, with a worn-out lead screw, and a rickerty tail-stock and a slippery belt, and I was kept there turning bolts for several months. The foreman did not take any interest in me, there was nobody in the shop who tried to teach me anything, and if I learned anything it was because a boy absorbs something from his surroundings in four years, and he may be able to pick up something for himself if nobody helps him. That really is the condition of the apprentice boy of most railroad shops in this country to-day. So that if we want to do anything to help him, do not start with an ambitious scheme of giving him a technical education, but let us look after him a little in the shop, and in the first place try and make a good mechanic of him. As a practical suggestion in this line I should think we ought to try and find some one in our shops who is a natural teacher, if we can, some good mechanic who has a faculty of imparting knowledge to others, and let him have some oversight of the apprentices. Let him be one that they can go to and ask questions, find out something about what they are working at, and after that establish a class of some kind and get started at a night school and gradually develop an attempt at education."

Does not this quotation suggest the true course? Is not a complete shop training the very thing to obtain which the apprentices entered the shop, and for which they contracted with their employers? Is it not the essential thing to most of them, in view of the future they have planned for themselves?

Most of the young men enter the shop with the intention of becoming journeymen—nothing more. Anything that will tend to make them better mechanics is to be encouraged. But the prime requisite is what in brief we designate as shop training. Mr. Forsyth has given his experience as an apprentice, and many others can give similar testimony as to the neglect of foremen and others to instruct them. The writer's own recollection is that he never was given a change of work without having to "kick" in order to get it. There is such an admirable opportunity in the shop to instruct a youth in more than the mere drudgery of his occupation that it is a pity to see it neglected. But neglected it is. It is not exaggeration to say that the average apprentice drags through a three or four years' term of service wholly dependent upon his own unaided efforts in absorbing knowledge, neglected by the foreman, assigned to the poorest work and the most decrepit machinery; seldom fully instructed as to how any piece of work should be done, and without an opportunity to gain an insight to general shop methods or to show what he is made of. The only piece of work that the writer remembers spoiling during his apprenticeship was spoiled because of the careless instructions of a foreman. He was told to perform the last operation on a rather costly piece of work by a method of measurement that could only be right when all previous operations on the work had been accurately performed. As bad luck would have it, somebody had blundered by a quarter of an inch at a point that was not essential in itself, but which used as a starting point for the final operation, led to the ruin of the piece. In this case the apprentice learned to check other people's work before he trusted it implicitly, and furthermore, that there was a right and a wrong way to measure work; but he found it out without the aid of the man who should have been his careful instructor, and at the expense of the company.

When a boy is given a piece of work that is new to him, it would save the foreman much future trouble and greatly encourage the boy if he was told all there was to be known regarding the seperate operations and the why and wherefore of each move. But this is seldom done. As an example let us suppose that the boy is given his first piece of taper work. How is he told to go about it?

The chances are that the tail-stock is set over by judgement merely and several trial cuts taken, whereas it could be set over by calculation to almost the correct position. The apprentice is not told that if the drawing calls for a taper of one-quarter inch in six inches and the work is 21 inches long over all, the tail-stock can be set over $\frac{7}{16}$ inch and will be in approximately correct position. Nor is he told to keep the tool the same height with relation to the centers during the entire job until he has spoiled a piece of work by failing to do so, or, if so instructed, he is not told the why and wherefore. Here is a case where if the foreman had taken the time and interest to properly instruct the apprentice, the latter would have had some practice in arithmetic and geometry without going outside of the shop to receive it. He would

also have been taught to think for himself. And the number of such cases is legion.

Instructions of this character are only cited to show that many of them are incomplete and misleading. One of the most frequent mistakes made is to ignore the fact that the average boy has not learned to think for himself or to make a practical application of his knowledge. A little encouragement and a drawing out of the young man in the early part of his apprenticeship when he is enthusiastic will give him the right start and will repay both foreman and employer by the enhanced value of his services later on. He should be instructed in the reading of drawings, in which he is generally woefully deficient. In a recent issue of *Cassier's Magazine*, the editor says:

"It may appear as a curious fact that many men who have had years of experience in shops and who are good workmen seem to be afraid of drawings. While working to them with accuracy and finishing their jobs satisfactorily they never seem quite at rest in regard to the meaning of their drawings, and frequently remark: 'If I had another job of the same kind to do I could get through it in much less time.' This means, practically, that if they had a model before them instead of a drawing they could turn out their work more easily. It raises the question, too, whether it would not pay to give more attention to making drawings plain and to teaching the men to read them. Shading of parts and increasing the pictorial effect in general, so as to make one piece stand away from another, would seem to be a good thing, and in this respect some of the older forms of shop drawings might well be taken as examples worth following. To-day many of these out-of-date drawings are considered as having been wasteful of drawing-office time and uselessly elaborate, and yet they had good points. They told their story in a way quite foreign to the modern blue print."

And yet blue prints have come to stay, and the apprentice should be instructed in the reading of them. Another course of instruction never open to apprentices is that which pertains to the general principles underlying shop practice and methods. He learns how to perform certain operations at the bench, on the lathe, planer, boring mill or other machine, but he is never given a broader insight into the work of the shop.

If those who would inaugurate a movement toward a higher education among apprentices will consult with a few foremen or level-headed journeymen who take an interest in the apprentices and are fitted to speak of their needs they will be surprised to learn of the eagerness with which these boys seek instruction in reading drawings and in practical matters that could be imparted daily in connection with their routine work. This want, we reaffirm, is the first one to be satisfied, and having taken care of the apprentice in the shops, the evening drawing class and other courses of instruction can then be provided (and we think they should be provided) when they will be better attended and will yield better results.

There are to-day so many well-educated young men seeking a practical course to supplement a college or technical training that it is proper to put them in a separate class by themselves. They will need no instruction in drawing, mathematics, physics, etc., but will require a special shop course, better adapted to their future course as engineers or specialists rather than journeymen. This is not an apprenticeship proper, for its object is not to teach a man a trade. And yet these young men can usually bring such talents and knowledge to their work that it will pay a railroad company or manufacturer to admit them to their shops and give them the course they seek. Such an arrangement is a special one, and is bound to vary with the circumstances.

What is, therefore, needed for the regular apprentice is thorough instruction in the shop and in shop matters. This is the first and great essential. Then the other lines of instruction, such as evening classes in drawing, etc., may be undertaken, and where this is done we believe the employer will not only have the satisfaction of carrying on a good work among his fellow-men, but he will reap an immediate reward in the greater value of the services of his apprentices and in their loyalty to his interests.

Gen. W. W. Duffield, Superintendent of the United States Coast and Geodetic Survey, has announced the completion of the transcontinental triangulation along the 39th parallel of latitude. The line extends from Cape May on the Atlantic to Point Arena, Cal., on the Pacific, and is 2,625 statute miles in length.

Notes.

In an article on "the fastest train in the world," *Engineering* gives the particulars of a trip of one of the regular trains on the Caledonian Railway. The time table of this road now contains the schedules of nine trains averaging over 55 miles per hour, two of which reach the average speed of 60.9 miles per hour. In 1884 the time occupied by the quickest train between Carlisle and Aberdeen was 7 hours and 22 minutes; to-day it is 4 hours and 31 minutes. The train which our contemporary timed consisted of three composite cars, one sleeper and one van, all carried on four-wheeled trucks. The weight is not given. From Carlisle to Perth the train was hauled by an engine of the "Dunaclaster" type, with two pairs of drivers 6 feet 6 inches in diameter, a leading four-wheeled truck, and 18¼ by 26 inches cylinders. The average speeds are given in the accompanying table:

	Miles.	Chains.	Min.	Sec.
Carlisle to Sterling	117	60 in.	119	5 = 59.3
Sterling to Perth	33	2 "	33	30 = 59.1
Perth to Forfar	32	40 "	32	1⅗ = 60.8
Forfar to Aberdeen (tickets)	57	10 "	63	40 = 53 7
Rockliffe to Bannockburn	111	25 "	110	40 = 60.3
Cargill to Kirriemuir Junction	18	26 "	15	42 = 70.1
Elvanfoot to Strawfrank Junction	20	43 "	16	55 = 72 8

As already stated this is a regular run and has been made nightly for many months.

Curious defect has been discovered in the Buda Pesth underground railway. There are not enough ventilating apertures in the tunnel and the trains rushing through it compress the air in it like that in the tube of a Zalinski pneumatic gun. On some occasions the cars are said to have been lifted from the track and the passengers have been almost suffocated. One stretch of tunnel, two miles long, has only a single ventilating aperture, making it almost an air-tight compartment.—*Engineer.*

A correspondent in the *Practical Engineer* says that on the Midland Railway, in England, no complete examination is made of a new locomotive boiler for five years, and even then it is the greatest rarity for a firebox to require patching. A few short stays to be replaced, and perhaps the firehole ring rivets, owing to the heads being burnt, is the sum total of the repairs usually required.

At a recent meeting of the German Institute of Gas and Water Engineers in Berlin, a paper was read by Mr. Koerting, of Hanover, on gas motors for producing electrical energy. Great advantages were claimed for this system. The gas plant is cheap in first cost, occupies but little space, and utilizes a large proportion of the energy of the fuel. The relative efficiency of steam and gas engines is shown by the following figures:

	Per cent. useful effect		
Horse-power.	Steam engines.	Illuminating gas motors	Producer gas motors.
10	2.2	9.1	7.3
50	4.6	9 9	10.2
100	6.9	10.9	12.9

Mr Harry Pollitt, Chief Engineer of the Manchester, Sheffield & Lincolnshire Railway, who has recently been in this country inspecting our railways, is credited with the following expression of opinion just prior to his departure for England: "The feature of your railroads is vastness as compared with compactness in ours. The ability of your managers to arrived at certain results by short cuts would not be recognized by our officials, but it is almost necessary when the extent of your systems is taken into consideration. These remarks, however, do not apply to the Pennsylvania and New York Central railroads, which, without wishing to discriminate, I consider far superior to your other roads. I was particularly impressed with the thoroughness and nicety of detail of the Pennsylvania system, and surprised how closely our methods have been copied, and in certain respects improved upon. You have one advantage which, for practical economy, is incalculable. I refer to the superior intelligence of your conductors, engineers and other employees over ours. That is the basis of your arriving at results with celerity and safety, whereas we have to hedge our view of necessities with more red tape. Taking your systems as a whole, they are marvelous examples of energy, ingenuity and administrative ability."

A series of experiments with glass bearings for line shafting recorded in the *Iron Age* by Mr. Geo. D. Rice, go to show that where everything is in good alignment and properly put together, the glass will work well, but pulleys out of balance or shafting out of line will break the bearings. The glass bearings must, in any case, be held in elastic boxes or supports, wood being the best material to interpose between the glass and the iron hangers. Glass on glass will run without oil and with very little heating; with oil the heating disappears and the friction is low. The author says: "A summary of the tests would seem to indicate that glass bearings are not so reliable in cases of emergency; at the same time glass bearings in ordinary uses and correctly applied require less oiling, develop less friction and are undoubtedly useful in many places, and there yet may be a future for them, regardless of what experiments may bring out for or against them."

The satisfactory subdivision of hulls into water-tight compartments has long been a serious problem for shipowners and shipbuilders. Mr. D. F. Black, whose name is associated with some of the best-class vessels built on the Tyne, has invented an improvement on the present practice which may overcome financial objections to greater precaution, and certainly cannot fail to impress the owners of passenger steamers, which in these days of competition must be safe at almost any cost. The object of the invention is to minimize the risk of a vessel sinking after collision with another at sea, when, as not infrequently happens, the vessel is struck at or near a bulkhead, and the inventor proposes to gain the desired result by branching each bulkhead on both sides instead of carrying them right across the ship, and by that means confining the inflow of water to only one of the two compartments, which under the existing arrangement would be involved. On the basis of a cargo vessel of 5,000 tons dead weight, Mr. Black calculates that only 9 per cent. of the total hold storage is cut off in the branching, and that even that ueed not be lost, as provision could be made for the utilization of the spaces. The increased weight is only ½ per cent. of the total deadweight. In accommodation for passengers on passenger vessels purely there would be, of course, a certain sacrifice, but the greater safety would in the long run be an important set-off.—*The Steamship.*

On December 5, the United States gunboats *Vicksburg* and *Newport* were launched at the Bath Iron Works, Bath, Me. These boats are of composite construction, having steel frames throughout, over which is planking covered with copper. The advantage over a steel skin is the comparative freedom from accumulations which require steel ships to be docked frequently to have their bottoms scraped. The boats are 200 feet long over all, 36 feet beam, 12 feet draft, and of 9,000 tons displacement. The engines are three cylinder triple expansion, of 800 horsepower, and the speed is 12 knots. The coal capacity is 300 tons. The sail area is 11,500 square feet. The armament consists of six 4-inch guns, four 6-pounders, and two 1-pounders, all rapid-fire guns.

The old-fashioned four-wheeled coal cars known as "jimmies," holding about six tons each, are gradually going out of use on the Lehigh Valley Railroad, and are being superseded by the large eight-wheel cars, which carry 60,000 pounds. The former are liable to jump the track, and trains composed of them frequently break in two when starting or crossing a "summit," or "buckle up" when stopping suddenly or backing on a curve. For this reason the company has decided to retire them from service as fast as they wear out or are damaged by accident, in case the cost of repairs necessary to put them in running order shall exceed the sum of $14. In order to ascertain this cost the damaged cars are examined by an expert car-builder, and upon his verdict the cars are either sent to the shop for repairs or are "broken up" for firewood. Properly speaking they are not broken up, but are taken apart, piece by piece, and the wood is sawed up for use under locomotive boilers, while the wheels and other ironwork are relegated to the scrap-pile. One man can usually break up two cars a day, receiving one dollar a car for the work.—*New York Evening Post.*

In an article on high buildings in New York City the *Scientific American* thus describes the most notable building under construction in the city, and for which ground has been broken on Park Row, opposite the Post-Office; "It will cover an area of nearly 15,000 square feet, and in no part will it be less than 25 stories in height. The front facing the Post-Office building will be 27 stories in height. the top cornice being 336 feet above the street level. The two flanking towers will each contain two stories to be used as offices, the cornice of the towers being 355 feet above the street and the top of the lantern 386 feet above the same level. The foundations will extend 34 feet below street level, making the total height of the structure from top of piles to top of lantern, 420 feet. The foundation will consist of piling capped with 10 inches of granite bedded in cement. Upon this will be 4 feet 9 inches of brickwork, stepped up to a granite capping. Upon this will be placed a grillage of steel I-beams and a series of huge box girders, some of them 8 feet deep, for distributing the pressure of the columns evenly to the brickwork. The largest of these girders weighs 55 tons. The approximate weight of steel in the building will be 9,000 tons; the total dead and live load will be about 50,000 tons, distributed upon some 4,000 piles.

The most recent and most important step thus far taken in the United States in the application of the storage battery to electric-railway work, says the *Electrical Engineer*, is embodied in the installation just completed by the Electric Storage Battery Company for the Union Traction Company of Philadelphia. The plant under consideration is situated at the end of a feeder, 11 miles long. This year it was decided to extend the line several miles, and it was found that it would be necessary either to build a new power-house or install a battery sub-station, as the required addition to the existing feeder system would necessitate such an enormous outlay for copper as to render it commercially impossible. The cost of copper alone, to carry out this extension and double the service on the section, would be four or five times the total cost of a battery installation to fully meet all the requirements; and a new power-house was out of the question on account of the heavy operating expenses. Before the extension was made the pressure at the end of the feeder was barely enough to operate cars on schedule time, and the pressure varied as much as 50 per cent. Under the new arrangement, the load on the section varies from 100 to 700 amperes; the feeder carries a constant load of 400 amperes, the battery discharging or charging to the extent necessary to maintain this condition. The result in actual practice is found to be that the feeder load remains constant at this average current and is absolutely independent of of the fluctuating demand on the line. The battery-house contains 248 cells. Each cell contains 13 plates, type "G," chloride accumulator. The maximum discharge rate of the battery is 400 horse-power for one hour. The plates are contained in lead-lined boxes, mounted on two tiers of oil insulators. The connections are all made by continuous weld, no mechanical contacts being used throughout the battery.

The Royal Blue trains on the B. & O. Railroad made some remarkable runs in November. Probably the best performance of the month was on Nov. 15. Train 507 (the Chicago limited), with engine 1308, hauling 11 cars, the entire train with the exception of three cars being vestibuled, left Camden Station, Baltimore, at 7:04 p. m. and arrived in Washington at 7:52 p. m., being a run of 40 miles in 48 minutes. This train covered the distance between Muirkirk and Alexandria Junction, on the Washington Branch, 8.1 miles, in seven minutes. This was an exceptionally good run, when it is taken into consideration that the speed had to be slow through the cities of Baltimore and Washington, and there was one slow order on account of sewer construction.

In the January number of *Harper's* a paper entitled "Science at the Beginning of the Century," by Dr. Henry Smith Williams, will be an important contribution to the history of nineteenth-century civilization and will be followed by other papers showing the progress of scientific discovery during the last hundred years. These papers will be fully illustrated.

CONSTRUCTION AND MAINTENANCE OF RAILWAY CAR EQUIPMENT.—IX.

BY OSCAR ANTZ.

(*Continued from page 339, Vol. LXXV.*)

BRAKEBEAMS.

On account of the great pressure exerted by the air-brakes, brakebeams must be made strong and stiff and wooden beams have been almost discarded by many roads. Nevertheless, a wooden beam of ample proportions, well trussed and of good material has considerable merit, is cheaper and easier to repair than a metal beam and is therefore still used by some roads. Such a beam is shown in Figure 57. *A* is the wooden beam trussed by a one-inch rod *B*, passing at the ends through washers *CC* and at the center over the malleable iron fulcrum *DD*, through which the truck lever passes and is attached by means of a pin. This fulcrum as well as the brakeheads *EE* are fastened to the beam by means of bolts.

Metal brakebeams in large variety are in use and are giving more or less satisfaction. Almost every shape of iron and steel has been tried, such as rectangular bars, angle and T bars, pipes and various shapes of pressed steel, the general shapes of the beams being similar to that of the wooden one, consisting of a main member and a truss rod. We illustrate only one of these beams and it is shown in Fig. 58. The main member consists of a piece of 2-inch iron pipe, *A*, slightly cambered at the center to the ends of which are fitted the brakeheads *BB*, which also serve as washers for the nuts of truss-rod *C*, which is of 1-inch round iron. A nut-lock placed under the nut prevent this truss from working off. The safety hangers are fastened to the clips *DD*. The brake lever fulcrum *E*, as well as the other castings on the beam, are made of malleable iron.

Brakebeams are hung either between the two pairs of wheels or on the outside, the height from the rail being about 13 inches, no part of the rigging being allowed to come less than 2½ inches from the rail. When inside hung, the beams are suspended from some part of the truck; when outside hung, from the body of the car. To make the brakes as effective as possible, the distance between shoes and wheels should always be maintained at a certain figure, about ⅜ inch being considered good practice, in order to get an average piston travel. This, of course, cannot be entirely accomplished in practice, but the manner of suspending the brakebeams can materially aid toward this end. When suspended from the carbody or truck bolster, the brakebeams will be lower when car is loaded and springs are compressed than when car is light, and the conditions are therefore not the same. If the brakeshoes are adjusted when the car is light, which is the general practice, they will be too far away from the wheels when car is loaded, and if adjusted under a load, they would probably be too close when the car is light, and cause the wheels to slide. It is therefore preferable to suspend the brakes from a part of the truck which bears a fixed relation to the wheels, and this is found in the spring plank or transom when the latter is used.

Fig. 57 shows the usual manner of suspending outside hung brakebeams. The brakeheads *EE* have holes cast in their upper ends, through which is passed the hook on the end of the brakebeam hangers *FF*, which are made of 1-inch round iron; the upper ends of these hangers are bent in the form of an eye around another eye on the end of a plate *GG*, which is fastened to some part of the floor frame of the car by two bolts, and also has a hook turned on its top to further secure it. To prevent the brakebeam from falling on the track should a hanger break, safety hangers are provided, which are usually made of three links of about ⅝-inch round iron, *HH*, secured at the upper end to a hook plate *II*, and at the lower end fastened to the brakebeam by an eyebolt passing through the beam, or, in the case of metal beams, by some clip or other attachment. Safety chains should be hung so that there is a little slack in the links, to prevent wear on them, so that they will be in good condition should occasion require their use.

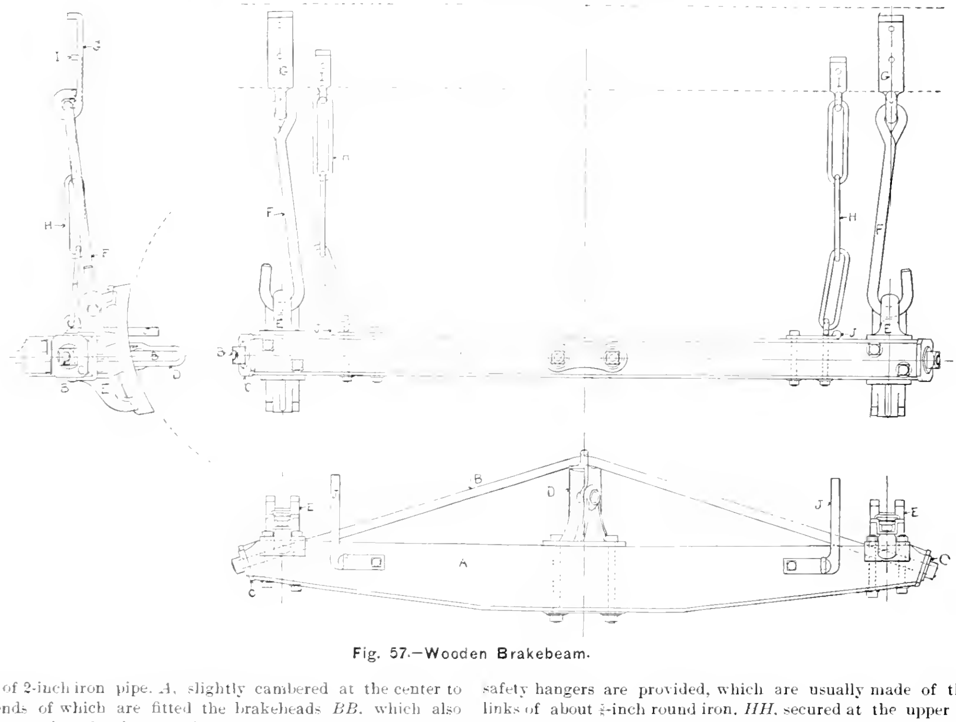


Fig. 57.—Wooden Brakebeam.

With outside-hung beams it is necessary to provide some kind of guide to keep the brakeshoes on the wheels laterally, and this is usually made of pieces of one inch round iron *JJ* fastened to the

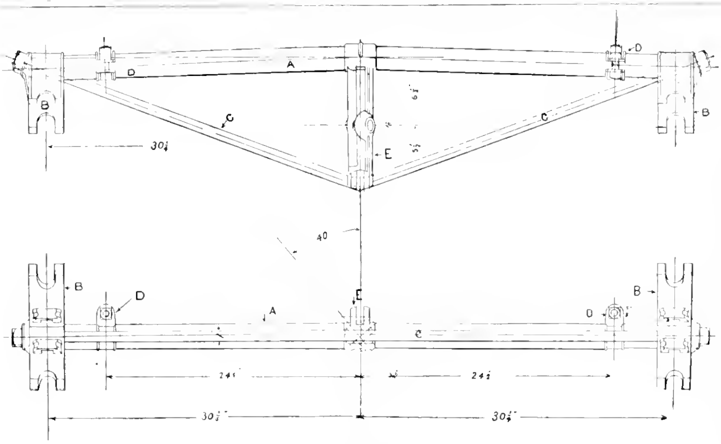


Fig. 58—Iron Brakebeam.

beam at points where they will come close to the inside flanges of the wheels.

Fig. 59 shows a method of suspending inside-hung iron brakebeams. On account of the short distance available the point of suspension on the beam is at the center instead of the top of the brakehead. The hangers *FF* are made of ⅞-inch round iron, bent

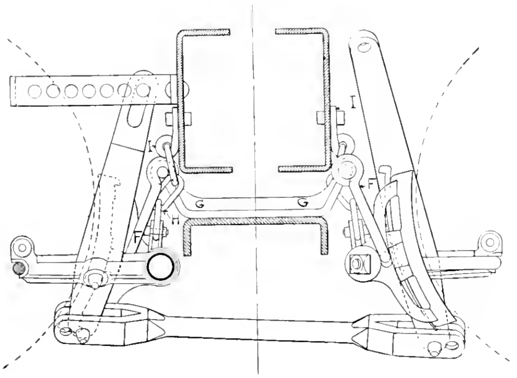


Fig. 59.—Inside Method of Hanging Brakebeams.

in the shape of a U, the upper ends being turned into eyes through which is passed a pin, which secures the hanger to the bracket *GG*. This bracket is of malleable iron and is secured to the spring plank by a number of bolts. The safety chains *HH* are made of three links of five-eighths round iron and suspended from eye-bolts *II*, secured to the truck bolster. Care must be taken that these chains have slack enough so that there will be no strain on them when the bolster is at its highest point. This figure also shows another method of securing the dead lever fulcrum, the slot in the dead lever allowing for its adjustment in different positions.

A standard shape and size has been adopted by the M. C. B. Association for brakeshoes, and this is very generally adhered to. The metal of which brakeshoes are made varies with different roads, and the best metal for the purpose is still a matter of discussion, although many tests have been made to determine this disputed point. Cast iron is no doubt the cheapest; but also the metal which wears out the soonest. Some other metals, while having better wearing qualities, have a tendency to wear the tread of the wheel to an alarming extent. Shoes combining several metals, as for instance pieces of ore metal sei tnto the wearing surface of a shoe made of a different ore, seem to come nearer to the conditions required than any other shoe yet produced. Further tests on this subject are looked forward to with great interest.

AIR-BRAKE APPARATUS.

The usual arrangement of the air-brake apparatus on a freight car is shown in Fig. 60. The train pipe *AA* of 1¼-inch pipe runs the full length of the car, the ends being located 13 inches from the center and to the right of it when looking toward the end of the car; the pipe is fastened at convenient points by means of pipe clips and lag screws into the sills of the car. It is not always possible to run the pipe in straight lines as shown, and it has to be made to clear obstructions, lowered or raised perhaps to pass under or through the body bolsters, and when ths is necessary, the pipe should be bent and no elbows or other fittings used. The pipe should be blown out to remove scale and dirt before putting the different pieces together, and the joints should be made with oil or varnish, and no red or white lead should be used, as this is liable to get into the brake apparatus and cause trouble. The ends of the train-pipe are provided with angle-cocks *BB*, which when a train is in service are open on all the cars excepting on the rear end of the last car. The handle of the angle-cock is curved to the general outline of the cock, bringing as it is possible without interfering with its operation, and when open or in running position it stands parallel to the pipe, in order to prevent as much as possible the liability of having the cock closed accidentally when the train is running by rocks or other missiles which might be picked up by the suction of the train. Into the angle-cock is screwed a dipple to which is attached a piece of rubber hose 22 inches long, at the other end of which is a clutch coupling provided with a rubber gasket. To connect two cars together the couplings of the two adjoining hose are interlocked,

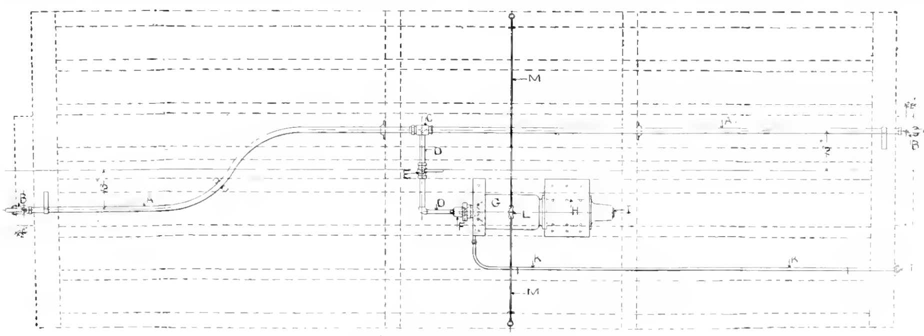


Fig. 60.—Air-Brake Apparatus.

the gaskets making a tight joint. When not coupled to another hose, it was customary, until a short time ago, to hang the loose end of the hose into a so called dummy coupling, to prevent dirt and dust from getting into the hose and eventually into the other brake apparatus; but it has been found that this caused considerable damage to the hose on account of it being kinked when thus hung up, and, as the joint was not dust-proof, it did not exclude dirt entirely, and recently almost all roads have discarded the dummy coupling, allowing the hose to hang down when not coupled.

Near the center of the car, in the train-pipe, is located the strainer and tee *C*, which connects the cylinder with the trainpipe, the strainer part consisting of a piece of perforated tin which prevents foreign substances from entering the brake apparatus. From the strainer leads the cross-over or branch-pipe *D*, in which is located the cut-out cock *E*, by means of which the air can be cut off from the cylinder of the car without preventing it from passing through the train-pipe to the rear cars. The branch pipe is connected by means of a union to the triple valve *F*, which is of peculiar and delicate construction, allowing air to pass, when in release position, from the train-pipe into the auxiliary reservoir *G*, where it is stored until needed for braking purposes, when by a movement of a valve in the triple, the air is allowed to enter the cylinder *H*, forcing out the pison and piston rod *I*, which operate the push rod and set the brake. When brakes are to be released, a reverse motion of the valve establishes communication again between the train-pipe and reservoir and the air in the cylinder is exhausted into the atmosphere through a port on the side of the triple. Ordinarily it would be sufficient to exhaust directly into the atmosphere at this point, but it has been found that on long grades it is often desirable to retain a small amount of pressure in the cylinder, after the higher pressure used in braking has been released, and for this purpose there is provided the pressu-reretaining valve *JJ*, connected to the triple valve by the ⅜-inch pipe *KK*. This valve is weighted so that it will remained closed until the pressure under it exceeds 10 pounds, thus insuring that pressure in the cylinder at all times when the valve is in use. When this pressure is not required on level track, etc., a handle is turned which allows the air to escape directly to the atmosphere. The pressure-retaining valve is usually located near the hand brake, within easy reach of the brakeman when passing from car to car. The pipe is fastened to the car by staples driven into the sills. The cylinder and reservoir are attached to blocks of wood which are secured to the frame of the car by bolts passing through the sills. The piston in the cylinder is made tight by a leather gasket, which is forced out against the cylinder by a steel ring, and is held in place by a follower. When air is released from the cylinder after having been applied, the piston is forced back to the end of the cylinder by a steel spring surrounding the piston rod. The reservoir is provided on its top with a release valve *L*, which can be operated from either side of the car by means of handles *MM*. It is necessary sometimes to release the brakes by this means, when for some reason there is not sufficient pressure on the locomotive to overcome the pressure in the reservoir and cylinder. In the bottom of the reservoir is placed a plug to drain out condensed moisture.

The operation of the air-brake is as follows: A pressure of 70 pounds is carried in the train-pipe and auxiliary reservoir when the train is running, or brakes are released. When the brakes are to be applied some of the pressure is exhausted from the train-pipe which causes a movement of the slide valve in the triple, and allows air to enter the cylinder through a pipe passing from the triple, and through the reservoir. For making ordinary stops, only a small amount of air is exhausted from the train pipe, and the triple does not make a full connection between cylinder and reservoir, causing only a low pressure in brake cylinder. When, however, as in the case of emergencies, a quick and full application of the brakes is necessary, all the air possible is exhausted from the end of train-pipe, which causes a greater travel of the slide valve in the triple, opening another valve which allows some of the air still in the train-pipe to enter directly into the cylinder, reducing the pressure in the pipe very quickly to the rear end of the train and utilizing some of the air which would otherwise have to be exhausted to the atmosphere.

As pressure is constantly carried in the pipes and reservoir when brakes are released, a failure of any part under pressure, such as the bursting of a hose, or when the hose is uncoupled by reason of the train parting, will allow the air to escape and apply the brakes and the train cannot proceed until the damage has been repaired.

(To be Continued.)

Shall the Cubic Capacity of Ordinary Box Cars be Increased?*

BY H. H. PERKINS.

The report of the meeting of the New York Railroad Club, held Feb. 20, contains an exhaustive and very interesting handling of the subject of large cars, and desiring to hear the question of maximum size of cars discussed, and thinking it might interest others, the attention of the committee was called to it; and they, instead of giving me bread, gave me a stone in shape of a request to prepare a paper on the matter to read at this meeting. Like the little boy, who presented himself before his mother with clothes soaking wet, when asked how they came so, replied that a boy dared him to jump into the river, where it was over his head, and he wasn't to be dared—neither was I.

Many of the members may have read the New York report, and it would be presumptive in me to expect to add anything thereto. It was with the expectation of hearing from others that the subject was mentioned; and, claiming no scientific or mechanical knowledge to impart, I can only relate the personal experience and reminiscences of a freight man, for which please bear with me for the few moments you will be detained.

My first recollection of freight cars is a four-wheel car on the Boston & Maine; but, as a good place to fish or a half-holiday from school had more interest for me in these days than the dimensions of cars, I can only estimate them at about 20 feet long and 7 feet wide. When first employed—a boy—in a freight office, I can recall that 7 tons were considered a carload. When old enough to tally freight into cars, the dimensions were 28 feet long, 7 feet 9 inches wide, and 8 tons a carload; when 10 or 12 tons were put in by accident or design, although the fear was often expressed that they might break down, no one appeared to worry over a little thing like that. Later, these same cars were rated as 10-ton, and the same size, with probably larger journals, were branded capacity 24,000 pounds.

During these years and changes, the forests in the immediate neighborhood of the tracks were being consumed by fires under the locomotive boiler and elsewhere, or buried under the ground in the shape of ties. Lumber was cut in saw-mills with a single upright saw, and carted in the rough to where it was to be used, there dressed by hand as needed. Soon wood and lumber, disappearing from alongside railways, had to be obtained from distant points. Transportation, at first too expensive by rail, followed the water routes; but improved mills and machinery, growing towns and cheaper rail rates created a demand for manufactured lumber. It began to be shipped in the 28-foot cars, which being hardly long enough for two fourteens, a demand for longer cars for lumber resulted in the 30 and 34-foot car, the latter about 8 feet wide and 6 feet in the clear becoming the standard—allowing two 16's to 1. The old 28-foot car began to be despised by shippers, until it is difficult to induce them to load such, even with sand or pig iron—they feeling they are not treated fairly when shown a small car to load, it being much easier to stow a load in a large car, even when the bulk does not require it.

Furniture and carriages, which had been manufactured at small shops in the neighborhood, where used, began to be made some distance away, nearer the lumber supply, as it was cheaper to transport the finished product than the rough lumber, including refuse and waste; and as the classification, on which freight charges were based, favored large cars, a demand was created for even a larger car than the 34-foot, manufacturers holding out inducements to roads to build them for these particular freights. About the time the furniture cars first made their appearance, at a meeting of the employees of a certain road, a freight agent reported to the superintendent that a rival road had built some furniture cars, and he could get no more of that class of freight; but, if the road would

*From a paper read before the Central Railroad Club in November, 1896

only build a few such cars, he told how much business he could secure. The reply of the superintendent contained considerable truth when he said: "If this road should build furniture cars, the other road would only wait until they could take their measure to build larger"—a prediction that was fulfilled, and both roads have since furnished just as large furniture cars as will run under the bridges and through the tunnels.

Shippers like to get big cars, even when the freight does not actually require it, but the demand for these excessively large cars was undoubtedly influenced and over-estimated by soliciting freight agents, who, under implied promises from shippers, represented to the authorities that a supply of large cars would add materially to the earning capacity of the roads, more than facts warranted. My own doubts were raised on this subject, when I could see standing at a certain carriage factory from one to five of these large cars, belonging to two or three different roads, sent there by orders of the soliciting freight agents, and kept standing there for weeks or months, if necessary, to be there in case if the carriage factory received an order, it would not ship via the other road for want of a big car. If it is necessary to keep cars standing like that for loads, it certainly does not pay to build them to carry freight at ordinary rates. Probably, the soliciting freight agent reported securing a carload from the other fellow, carefully omitting to mention the expense, estimating a car idle as a certain amount per day. Car service rules have done away with this abuse to a certain extent.

Furniture and carriages were the first to cause the 34-foot to grow from 6 to 8 feet high inside; but the fact these cars could be obtained stimulated the manufacture of baskets, barrels and boxes, where the supply of lumber was cheapest to be transported where used. These light goods demanded even larger cars; and the 40-foot is now frequently seen, and even a few 60-foot freight cars have been hauled over the roads. Hay, first carried in ordinary cars, now demands the largest from the prairies of the West to the towns and cities of the East. How long will shippers of these light commodities be satisfied with the present size of even furniture cars? Will not the soliciting agent represent that the demands of shippers require 45 or 50-foot cars, 8-foot high, 9-foot wide, with a capacity of 1,500 or 2,000 bushels of grain, instead of 1,000 as now, and 500 as formerly?

Some little time ago a shipper came to me representing he was in a great hurry to load a car of lumber, and, as usual, requesting a large car, "right away, quick." There happened to be a furniture car over the home road of which the lumber was to go; and, in order to send it home, it was placed on track for him to load. Not a piece of lumber was put in the car for two days; and, having use for a furniture car to same destination, it was taken away and a standard car substituted; and the change was hardly made before that same shipper was in the office demanding the return of the big car, as he had been two days getting out extra lumber in order to fill it. This instance is related to show that the demand for large cars is only created by a supply and, once furnished, becomes the expected. The tendency is to fill cars, whatever the size, as the larger the car the greater the sale; and the carload being the standard for minimum freight rates, if the customer is good, the shipper would fill a barn as a carload, if possible. I once knew of a man selling a carload of brick, who filled one of the old 10-ton cars with brick to the roof; it never moved until it was entirely unloaded and then—to the shop. It must be admitted that the shipper benefits in larger sales at one time; but would not the same amount be, eventually, hauled in two cars, were there none of the excessively large cars? and, perhaps, the railroad may benefit a little from concentration of weight on eight wheels; but, when there is extra haulage and switching necessary to get special cars to certain tracks, where standard cars may may be standing, it is doubtful if these cars add very much to the earnings of a road.

Years ago, in conversation with a then division superintendent, afterward a railroad manager of distinction, I remarked we would see cars carrying a thousand bushels of grain from Chicago to New York; he replied: "Never, as the tendency would be to reduce the size of loads rather than to increase them." We have both seen more than was predicted.

The country is growing, and business is not only keen among manufacturers, but also between railroads; and, unless the railroads can agree among themselves to limit the size of cars, the 60-foot car is bound to come. It is here for empty barrels, next empty boxes and baskets, carriages, furniture, hay and agricultural implements; if they hold off, one railroad against another will get them, and shortly other commodities will demand them.

The question placed before the committee was, what will be the maximum size of box freight cars? It is limited now on Eastern roads by the height of their bridges, or size of their tunnels, but on the prairie roads, apparently, by the sky and the horizon. Will it remain 40 feet long, 15 feet from top of rail, 10 feet wide, 30-ton capacity, which is now about the practical maximum; or will it, in a few years, evolve to 60 feet long, 20 ft. high and more than 10 feet wide?

Some may claim these latter figures are impossible, but they are no greater than the present maximum appeared when railroads were first projected; and, although size of tunnels and height of bridges limit the maximum now, is there any limit to which changes in these can be made? Is the maximum always to be limited by the present tunnels and bridges, or will the Eastern roads have to increase the size of tunnels and bridges in order to haul what the Western roads can furnish patrons? It strikes me that the question whether large cars pay the roads has never been fairly considered; the subject only b ing looked at, as what has the other fellow done; what he has done, we can do; therefore, if one road builds cars 60 feet long, 50 ton capacity, straightway another follows suit, even if bridges and tunnels have to be enlarged to do it. There is no limit to what a roadbed can be made to bear. Is not the 50-ton car a probability, and the 100-ton car a possibility? Would it not be better for the associate roads to agree on a maximum size and refuse to handle or haul beyond that limit, and the plant of railroads can gradually be made to conform to that standard?

Apparently, the concensus of opinion, among those quoted by the New York committee, is that the standard of length will have to be increased to 40 feet, and if this is agreed to by the associate roads, the quicker some agreement is entered into by all roads not to receive or haul longer cars the better; otherwise, the 50 or 60-foot car will be tendered them inside of a year after the 40-foot car is accepted as the standard; and, thereafter, it will occupy the position of the 40-foot at present.

There was to have been a meeting of the New York committee, Oct. 6, in regard to limiting size of freight box cars, but I have seen, as yet, no report of their conclusions, though, undoubtedly, it will recommend the increase of the present standard to 40 feet in length. But will that be the limit? Is not the 60-foot 100-ton car in process of evolution?

The Progress in the Manufacture of Iron and Steel in America and the Relations of the Engineer to It.*

BY JOHN FRITZ, BETHLEHEM, PA.

Having frequently been asked by members of the American Society of Mechanical Engineers, and others, to write a paper on the manufacture of iron and steel in this country, showing its progress since the time of my first connection with it (and quite recently I have not only been asked, but urged to write a paper on this subject from a mechanical and engineering standpoint, giving an outline of the early troubles, and showing the great improvements that have been made in machine tools and machinery, as well as in the manufacture of iron and steel), after some hesitation I have concluded to make an effort to respond to these requests. In complying therewith I shall to some extent quote from a paper read before another society of engineers, and give such additional items of my experience as I have thought would have been interesting.

As a beginning I will make a brief allusion to the mechanical engineer, showing his origin and growth, and what he has accomplished in the great field of metallurgy, and especially in the Bessemer and other important steel-making processes. It seems to me eminently proper that in describing the development of the mechanical engineer his growth should be considered jointly with that of the metallurgist, especially when we take into consideration how essential good iron and steel are to all engineers. In fact, it is the marked improvements in the manufacture of iron and steel that have enabled the engineers to surmount the difficulties and erect works that would have been well nigh impossible before these improvements were made; and to the mechanical engineer is largely due the credit of the marvelous improvements that have been accomplished. And here let me say that but few people know anything of the labor, the troubles, trials, vexations, surprises and disappointments that were encountered during the early stages of that now great industry, the Bessemer process; and, besides, all the physical danger to which they were constantly exposed.

When I look back and review the roll-call of memory, it brings to my mind faces of men who lost their lives while engaged in the performance of their duty; some of them were near and dear to me, being associated by the closest of personal ties. They are no more; but to those who knew them, and what they accomplished, their memery is forever sacred.

Prior to 1838 the manufacture of pig iron was in a primitive condition, that metal being practically all made in charcoal furnaces, producing from fifteen to thirty tons per week, and was converted into wrought iron in the old-fashioned charcoal fires, and was

* President's address presented at the New York meeting (December, 1896) of the American Society of Mechanical Engineers.

shaped into blooms for the rolling-mill, and into bars for the smith by a belve hammer. The furnaces, forges, and mills were all driven by water power. and were kept in order by what was sometimes called a forge carpenter. or millwright. At this time the mills were all geared, the shafts being square, hexagon or octagon, according to the fancy of the millwright; the wheels were secured on the square shafts by wooden blocks, and in them were driven thin iron wedges; the segments of the wheels were secured to the center in the same manner; the roll housings were all set on wood. All this crude machinery the millwright was called on to keep in running order; consequently he became an important man.

In 1840 the use of anthracite coal and coke in blast furnaces was commenced. This required a much higher pressure of blast. Previous to this time the blowing cylinder had been made out of wood, the pressure of blast being very low, not exceeding one and a half pounds; hence a great improvement in blowing machinery became necessary.

In 1842 puddling began to come into more general use, and puddling trains had to be built, and better merchant or bar trains were now required; they were all geared, and gave much trouble. The machinist now had to be called in to help keep things in shape, and he soon took the millwright's place, and laid the foundation for the mechanical and metallurgical engineer.

In 1845 the rail mills were being built, and stronger and better workmanship was required. These mills were all geared, but the shafts were generally turned up, and wheels all bored out, and fitted up in a much better manner, which required more skill and better workmen. Puddling now became an important branch of the iron business, and the "Old Harry" was generally to pay to get the balls in proper shape; to do this mills were using the old Welsh hammer. Numbers of squeezers were tried and failed; finally the Burden squeezer was invented and adopted by the mills generally, and to this day is the best machine that has ever been devised for the purpose.

In or about the year 1848 "boiling" came into use, which was a great improvement over ordinary "puddling," and gave a new impetus to the trade. From 1848 to 1856 there was no great change or marked improvements made in the business. In 1857 the three-high rail mill was successfully introduced and in a short time practically revolutionized the manner of rolling rails. From this time on all the new mills that were built were driven direct, without gearing, and much stronger and better in every way. It was during this time that the great changes and improvements were being made in rolling-mill and blast-furnace machinery and also in machine-shop tools of all kinds, which enabled much better work to be turned out than had been previously possible; and this was an advance for the mechanical engineer, and prepared him for the great work that he was soon to be called on to accomplish.

In 1864 the Bessemer process was introduced, and it soon became evident that it would in a short time revolutionize the iron business. Its introduction and perfection will ever remain one of the most interesting and important epochs in the whole history of the iron business. It was now that the men that had been in training were called to the front, and nobly did they do their duty. This was the graduating period for them, and no set of men ever worked more faithfully or earned their diplomas more honestly than these men did. Their diplomas ware not made of parchment, but of bright ideas, hard work, and energy, coupled with a determination that made failure impossible.

Sir Lothian Bell, in an address before the Iron and Steel Institute in 1896, said: "In viewing the impressive but simple process of blowing a charge of metal it is difficult to realize the disappointments and the large expenditure of money and indefatigable energy required before its present condition was reached." I will go further and say that I do not believe it possible to describe the feelings of fear and anxiety that existed in the minds of those who had the immediate charge and were responsible for the result.

It is not the object, nor is it possible in a paper like this, to give a description of the process, or to even faintly describe the difficulties that were encountered in its incipient stages, but I feel as if I should do violence to my feelings were I to fail on this occasion to make some allusion to those brave and noble men who fought these early battles to a triumphant conclusion; and, as the Hon. Abram S. Hewitt has truly said, "The Bessemer invention takes its rank with the great events which have changed the face of society since the time of the middle ages"; nor am I unmindful of the assistance rendered by the brave and noble workmen who so ably supported their chiefs and who were ever ready and willing to face any danger or difficulty that might occur.

Having already stated that the Bessemer process was introduced in 1864, of course but little steel was made in that year. I do not propose to give you a yearly array of statistics, but in 1895 the production reached the enormous quantity of 4,909,128 tons of ingots. In the same year the production was of puddled iron 1,500,000 tons, making a total of steel and puddled iron 6,409,128 tons.

In order to show what the Bessemer process can do in coal and labor, as compared with puddling, the former can produce in 10 minutes 10 tons of steel ingots, with a consumption of twenty hundred of coal. It will require a puddling furnace 10 days, with practically three men, to produce a like amount of puddled iron, and will require about 20 tons of coal. The puddling is a hard, laborious and exhausting occupation. With the Bessemer it is care and attention only, but that it must have.

We left the blast furnaces in 1840, making fifteen to thirty tons per week, and produced in that year 286,903 gross tons. In 1895 we have furnaces producing between two and three thousand tons per week, and others building that are expected to make much more. The total output in 1895 was 9,446,308 gross tons, which exceeds the quantity made by any other nation.

It was the marvelous increase in the production of iron and steel which took place after the year 1865 that gave such a remarkable impetus to the engineering trades. The demand for Bessemer pig iron caused new blast furnaces to be built of much larger size than formerly. The blowing engines were required to be of much greater capacity and more powerful. The material used in the construction of these furnaces stimulated other branches of business, in many instances beyond their capacity. When the Bessemer process came into use blooming mills had to be built, new rail mills, billet mills, and plate mills; in fact the introduction of Bessemer rendered the old iron rolling machinery practically useless; consequently new, heavier, and more powerful mills had to be erected.

The rail mills, with one exception, are three-high, and fitted up with tables arranged for automatically handling the work, and they are equipped with every facility that will quicken and cheapen the handling of the material. In 1866 the Siemens open-hearth furnace for making steel was introduced, but it was some time before it came into general use; the Bessemer for quite a while held it in check. To day it occupies an important position, and, in connection with the Thomas basic process, one of the great metallurgical inventions of the age, is sure to become a strong competitor of the Bessemer process. When I allude to the Siemens open-hearth furnace I do not mean that their form of hearth and ports should be strictly adhered to, as there are other styles of furnaces which have their advocates; among them are the partial revolving hearth, which so far has shown good results, and it certainly has advantages over the fixed hearth. What I refer to is the Siemens regenerative principle, which is truly scientific and yet perfectly simple in its construction, and so far is the only method by which the metallurgist has been able to secure the heat necessary for making steel on the open-hearth plan; and all steel-melting furnaces, of whatever form the hearth has been constructed, use the Siemens regenerative principle. Much as I admire the Bessemer process and well know what can be accomplished with it, yet if the users of steel insist on lower phosphorus, it will have to be made in the open hearth, and by the Thomas basic proeess, as the ores that will make steel of high grade by either of the acid processes are, so far as known, quite limited; and the Thomas basic Bessemer requires high phosphorus, as the pig iron should have at least two per cent., and this is more difficult to obtain in quantity than the low is for the acid processes. Steel can be made in the open hearth, on acid lining, quite low in phosphorus, but at a greater cost, as you must start with first-class material, while the basic might be called a kind of scavenger. I do not say this in a disparaging sense, but, on the contrary, a material that is perfectly useless (so far) in either of the acid processes. can be utilized, and a fairly good steel can be made out of it, by the basic process, and it is this quality which makes it such an important improvement in the science of metallurgy. It is, however, like all other processes; if you want to make a good article you must have the proper material to start with. Now, while it is being rapidly introduced in many parts of the country, I think it proper to say that there are large users of steel of high quality that will only use the acid open hearth

There are several other forms of steel-making furnaces, among which are the Pernot and the Ponsard; both of them were designed for more rapid working. The former has an inclined rotating hearth, which keeps the metal in motion, and is supposed to work more rapidly than the fixed or stationary hearth. The latter (Ponsard) is in its construction very similar to the Pernot, it being designed to work more rapidly than the Pernot, and introduces blast same as Bessemer, thereby combining the two processes by blowing the metal partially, and then finishing it by the Siemens process. Both systems use the Siemens regenerative principle.

I have now mentioned the several processes for making steel rapidly, but to describe them fully would not only be impossible, but out of place in a paper of this kind, as it would require a large volume to give an intelligent description of them all; but I hope I have succeeded in giving you such an outline of the various processes as will enable you to form some general idea of them, and the results obtained, and shall again refer to them in speaking of the finished product.

Having given you a very brief account of the progress of the iron and steel industry from its infancy up to the enormous production in 1895, I shall now endeavor to show the wonderful changes that have been made in machine tools and shop practice.

(*To be continued.*)

On November 15 the electric current was turned on for the first time between Niagara Falls and Buffalo. The line is 26 miles long and the horse-power at present transmitted is 1,000, and is for the operation of street cars. The Power Company is, of course, prepared to furnish as much power as the demand for it arises. The interest in this case of power transmission is great. for the Power Company must compete with steam power, generated in a community where both coal and labor are cheap. There is no question about the ability of the company to successfully operate a long-distance transmission, but the interesting problem is what the power will cost in Buffalo. In discussing this phase of it *Electricity* gives the following adverse opinion: "In the Frankfort-Lauffen experiment, it will be remembered that the transmission of 300 horse-power was effected with an efficiency of 75 per cent., but cost five times as much when delivered as it could be generated for locally. In Fresno, Cal., where 1,400 horse-power is transmitted 35 miles by the three-phase system, and at San Bernardino, where 800 horse-power is transmitted 28 miles by the single-phase system, the delivered power is competing with power generated locally from coal costing $13 per ton. At Buffalo, however, coal costs but $1.80 per ton and labor is cheap. The commercial problems presented at Buffalo and in the far West are therefore entirely dissimilar, and it is our deliberate opinion that the Buffalo transmission cannot be a commercial success."

Personals.

Mr. John H. Drake, President of the Charleston, Clendennin & Sutton Railroad, died Oct. 21.

Mr. Peter Smith, Master Car Builder of the New York Central, at Rochester, N. Y., died at his home, Nov. 18.

Mr. Henry Terrell, Receiver of the San Antonio & Gulf Shore, has been appointed General Manager of that road.

Mr. S. M. Dolan has been appointed Master Mechanic of the Wiggins Ferry Company, with headquarters at St. Louis.

Mr. W. A. Bradford, Jr., has been appointed General Manager of the Hutchinson & Southern, with office at Hutchinson, Kan.

Mr. J. J. Thomas, Jr., has been appointed Master Mechanic of the Mobile & Birmingham Railroad, with headquarters at Mobile, Ala.

Mr. C. R. Peddle, Purchasing Agent of the Vandalia Line, has removed his headquarters from St. Louis, Mo., to Indianapolis, Ind.

Mr. R. H. Johnson has been appointed Master Mechanic of the Atlanta & West Point Railroad, with headquarters at Montgomery, Ala.

Mr. G. W. Russell has been appointed Master Mechanic of the New York, Philadelphia & Norfolk Railroad, with headquarters at Cape Charles, Va.

Mr. Charles P. Clark, President of the New York, New Haven & Hartford road, has been elected President of the Fall River Line, vice J. R. Kendrick, deceased.

Mr. W. C. Dotterer has been appointed General Manager of the New Orleans & Western, with headquarters at New Orleans, La., vice Mr. John M. Turner, resigned.

Mr. Wm. J. Fransioli, who has been acting General Manager of the Manhattan Elevated since the death of the late Colonel Hain, has been made General Manager.

Mr. George F. Peabody has been elected First Vice-President and Mr. E. M. Shepard Second Vice-President, of the Mexican Northern, with offices in New York City.

Mr. L. J. Buckley has resigned as Purchasing Agent of the Baltimore & Ohio, and has been succeeded by Mr. E. H. Bankard, who was Chief Clerk to Receiver Murray.

It is announced that the office of Chief Engineer of the Norfolk & Western has been abolished. Mr. W. W. Coe, who occupied the position, it is stated, will retain his connection with the road.

Mr. Frank Barr, Superintendent of the Worcester, Nashua & Portland division of the Boston & Maine, has been appointed Assistant General Manager of the road, to succeed Mr. George H. Evans, resigned.

Mr. Robert T. Baker has been appointed General Superintendent of the Morristown & Cumberland Gap, with office at Morristown, Tenn. He takes the place of Mr. H. M. Aiken, whose title was General Manager.

Mr. C. H. Coit has been chosen Vice-President of the Wheeling Bridge & Terminal Railway, with office at Hartford, Conn. Mr. H. W. Hayden has been chosen Secretary and Treasurer, with office in New York.

The office of General Superintendent of the Vandalia Line has been abolished, and it is stated that Mr. H. I. Miller will probably return to the Pennsylvania lines west of Pittsburgh as Assistant General Superintendent.

Mr. Charles E. Henderson has been chosen Second Vice-President of the reorganized Philadelphia & Reading Railway, in charge of freight traffic. Mr. Henderson will retain the general managership of the Philadelphia & Reading Coal and Iron Company.

Mr. G. M. Dodge has been elected President of the Fort Worth & Denver City Railway, with office in New York City. Mr. K. M. Van Zandt has been chosen First Vice-President, and Mr. Morgan Jones, Manager of the same road, with offices at Fort Worth, Tex.

Mr. J. D. Hawks, Vice-President and General Manager of the Detroit & Mackinac, has been chosen President of that road, to succeed Mr. C. H. Coster, and will retain his position as General Manager. Mr. George M. Crocker, Auditor and Purchasing Agent, has been chosen Vice-President in addition to his former duties.

Mr. Frank M. Baker, General Superintendent of the Addison & Pennsylvania, has been appointed a member of the New York Railroad Commission, to succeed Michael Rickard, deceased. Mr. Baker has been General Superintendent of the Addison & Pennsylvania since Nov. 1, 1882, and was before that date for ten years Station Agent on the Southern Central.

E. R. Reynolds, General Manager of the Long Island Railroad, has resigned. George C. Hubbell, the General Purchasing Agent of the road, has also resigned. The office of General Manager will now be abolished, and the duties will be assumed by the President. Mr. Reynolds has been in the employ of the company since 1879. He is a director and has had entire charge of the road's affairs since the death of Mr. Corbin.

Mr. Robert E. Marshall, Superintendent of the Altoona division of the Pennsylvania Railroad, committed suicide on Nov. 30, by shooting himself while at the home of his brother in Washington. He has for some time been suffering from nervous troubles due to overwork, and committed the act in a fit of despondency. He was 34 years old and entered the service of the Pennsylvania road in 1881. For five years prior to June, 1895, he was Superintendent of Motive Power of the Philadelphia, Wilmington & Baltimore, and since then occupied the position he held at the time of his death.

Mr. M. L. Hinman, who has been President of the Brooks Locomotive Works for the last four and one-half years, is in such poor health that he has retired from the position. At a recent meeting of the stockholders Mr. F. H. Stevens was elected President in his place. Mr. Stevens has been assistant to the President since 1892. Mr. Hinman has been active in the management of the company since 1869, and will continue as one of its officers. The other officers elected at the same meeting are: Vice-President, Mr. R. J. Gross; Treasurer, Mr. M. L. Hinman; Secretary, Mr. T M. Hequembourg; Superintendent, Mr. David Russel.

Mr. Frank S. Gannon has resigned the position of General Manager of the Staten Island Rapid Transit road and General Superintendent of the New York Division of the Baltimore & Ohio, to accept the appointment of Third Vice-President and General Manager of the Southern Railway, with headquarters at Washington, D. C. Mr. Joshua Smith, General Superintendent of the Trans-Ohio divisions of the Baltimore & Ohio at Chicago, succeeds Mr. F. S. Gannon as General Superintendent of the New York Division of that road, and General Manager of the Staten Island Rapid Transit Railway, with headquarters at New York City.

Mr. J. R. Kendrick, Third Vice-President of the New York, New Haven & Hartford Road, died very suddenly of heart trouble in Boston, Dec. 11. Mr. Kendrick was born in New Hampshire in 1833 and began business life as a clerk on the Central Vermont Road. In 1858 he became General Freight Agent of the Manchester and Lawrence Road, and in 1866 was appointed Superintendent. About 1870 he became General Manager of the New Orleans & Mobile, now a part of the Louisville & Nashville. In this position he made an excellent record for administrative ability, and soon received an offer of the Superintendency of the Old Colony. Since the acceptance of that position he has been connected with that system, being for many years General Manager. When it was consolidated with the New York, New Haven & Hartford Road, he was made Third Vice-President in charge of

the lines east of New London. He was held in high esteem by all his associates and subordinates.

Mr. E. M. Herr, Assistant Superintendent of Motive Power of the Chicago & Northwestern Railroad, has resigned that position to become the Superintendent of Motive Power of the Northern Pacific Railroad. Mr. Herr is a man of great ability and has had a wide experience in railroad service. He began railroad work as an apprentice in the Chicago, Milwaukee & St. Paul Railway shops. Later he became Engineer of Tests on the Chicago, Burlington & Quincy Railroad, then Superintendent of Telegraph, and afterward Division Superintendent. He then returned to the former road as Master Mechanic at Milwaukee. This position he resigned to become Superintendent of the Grant Locomotive Works. Upon the failure of that firm he went to Europe with several important commissions from parties in this country, and later made a second trip to Europe in connection with the project of the Russian Locomotive Works. On his second return home he took the position with the Chicago & Northwestern which he has just resigned. Thoroughness and ability have characterized all of Mr. Herr's work in these various positions and his present appointment is a well-deserved honor.

The many friends of Mr. John Hickey will learn with regret that ill health has caused him to resign the position of Superintendent of motive power of the Northern Pacific Railroad. He has held that position since 1891, prior to which he was in charge on the Milwaukee, Lake Shore & Western. The circumstances which have culminated in Mr. Hickey's resignation are particularly sad. In three years he has lost four children, his youngest son dying about one month ago. Those who know Mr. Hickey personally are aware of the depth of his kindly and affectionate nature, and can in a measure realize how severe these afflictions have been to him. His ability, his honorable, upright character and his justice in all his dealings with his fellow-men command the respect and affection of all who have been brought in contact with him. A touching exhibition of this affection occurred when several years ago he was absent from the president's chair at a convention of the Master Mechanics' Association, because of the death of a son. The telegram of sympathy which the association sent him was despatched with exhibitions of emotion seldom seen in a gathering of that kind. One of the highest officials of the road in speaking of Mr. Hickey's resignation a few days ago said:

"Mr. Hickey's service with the Northern Pacific commenced in April, 1891, and he has won the esteem and appreciation of every officer and employee, by the close and intelligent supervision which he has given to the work in his department, and the even-handed justice with which he has treated all of its employees. The necessity which compels him to retire from the company's service is regretted by every one, and it is hoped that the rest which he needs so much will speedily restore to him his usual strength and activity, and that a new career will open for him, which will confer upon him increased honor and prosperity."

Mr. Hickey bore his bereavement bravely and being urged if at all possible to continue his official service remained at his post, though he knew his health demanded a rest. At length, in justice to himself, he resigned.

David Leonard Barnes.

To his wide circle of friends and to the engineering profession at large the announcement of the death of David Leonard Barnes was a severe shock and created a feeling of personal loss and deep regret that a life in which so much had been accomplished, and which gave promise of so great a future, should be suddenly closed. It was in the nature of a surprise, for while most of his friends knew of his illness, few realized that his life was in danger. Mr. Barnes had been suffering from a malady since last spring, and had come to New York for treatment at a sanitarium, where he died suddenly on Dec. 15.

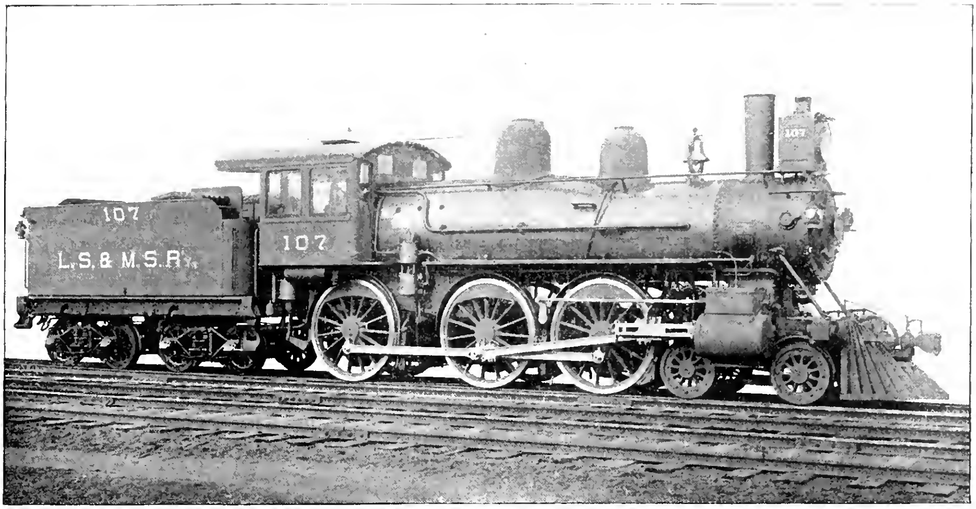
It is seldom that the death of so young a man has caused such universal regret. Though only 38 years old, few men were better known in engineering circles, and his engaging personal qualities and great abilities had won the admiration and friendship of a host of men. Mr. Barnes was a tremendous worker; it was the wonder of his friends how he found the time to accomplish so much, and this wonder was only increased by a closer acquaintance with him and a better knowledge of his diversified interests and pursuits. In addition to conducting a large consulting engineer's practice, he was on the editorial staff of the *Railroad Gazette*, and he found time to contribute many valuable papers to engineering societies and other technical organizations. He had a wonderfully active and fertile mind, and if his enthusiasm and activity occasionally brought his opinions in clash with those of others, it was seldom other than a most friendly combat.

Mr. Barnes was born at Smithfield, R. I., Aug. 23, 1858. When about 11 years old his father died, and he was thus early in life called upon to exercise judgment and self-reliance. At the age of 15 he engaged in town surveys at Providence, R. I., which work he dropped at the end of three years to take a course of study at Brown University and the Massachusetts Institute of Technology. From 1879 to 1882 he was employed in the machine shops of the Hinckley Locomotive Works and the Rhode Island Locomotive Works. Then he became chief draftsman in the latter concern, but after a year or two he resigned to take a similar position with the Rome Locomotive Works, a new concern at that time. He returned to his old position with the Rhode Island Locomotive Works in 1884 and remained with them for three years, during which time he also did some writing for the *Railway Master Mechanic*, and more or less consulting engineering work. In 1887, he went to Chicago and established a consulting engineer's business. He also at that time accepted a position on the editorial staff of the *Railway Review*, which he resigned in 1889 to take up a similar line of work on the *Railroad Gazette*. Since 1888 his work brought him into great prominence. He was consulting engineer for the New York underground railway, and later he was consulting engineer for the Alley Elevated Railway, in Chicago. Somewhat more than a year ago he was appointed consulting engineer for the Baldwin-Westinghouse companies, and produced the designs of a number of electric locomotives and trucks. These are only a few indications of his remarkable activity. His work covered practically the whole range of rolling stock and power for steam roads, elevated, street and electric railways.

Mr. Barnes was a member of the American Society of Civil Engineers, of the American Society of Mechanical Engineers, of the Institution of Civil Engineers (England), of the Western Society of Engineers, of the American Association for the Advancement of Science, of the American Academy of Political and Social Science and an associate member of the American Railway Master Mechanics' Association and the Master Car Builders' Association, and he was more or less active in the work of most of these societies. His papers and discussions before the railroad clubs are well known to our readers.

Mr. Barnes was married in April, 1896 to Miss Ida S. Irwin, daughter of Col. B. J. D. Irwin, U. S. A. Besides his wife, he leaves his mother, one brother and two sisters.

The Strong locomotive, which attracted so much attention some years ago, has been rebuilt into a four-cylinder compound. The four cylinders are all placed in the same plane, the two 16-inch high-pressure cylinders being inside of the frames, and the two 23-inch low-pressure cylinders being outside in the position ordinarily occupied by the cylinders of a single locomotive. The high-pressure cranks are 90 degrees apart, and the low-pressure cranks are each 180 degrees from their respective high-pressure cranks. The engine is claimed to be perfectly balanced, the low-pressure crossheads and pistons being made of special design to secure lightness. The L. P. piston rods are hollow, $3\frac{1}{2}$ inches outside and 2 inches inside diameter. The pistons are made of two steel plates $\frac{5}{16}$ inch thick, between which is riveted a cast-iron bearing ring. By this construction the low-pressure reciprocating parts are made as light as those of the high pressure cylinders. The boiler, frames, running gear and tender are the same as when the engine was known as the A. G. Darwin. The valve-gear is a modification of the Walshaert. The compound features were designed by Mr. Strong, and the engine was reconstructed by the Balanced Locomotive and Engineering Company, New York.



Ten Wheeled Passenger Locomotive—Lake Shore & Michigan Southern Railway.

G. W Stevens, Supt. Motive Power. Schenectady Locomotive Works, Builders.

Ten-Wheel Passenger Locomotives for the Lake Shore & Michigan Southern Railway Company.

The accompanying photograph and specification illustrate and describe one of a lot of ten ten-wheel passenger locomotives which the Schenectady Locomotive Works have recently constructed for the Lake Shore & Michigan Southern Railway Company, for service on the fast trains between Buffalo and Chicago.

The locomotives were designed by Mr. George W. Stevens, Superintendent of Motive Power of the Lake Shore & Michigan Southern Railway, in consultation with the Schenectady Locomotive Works, and possess many interesting features, inasmuch as the boiler capacity of the engines is in excess of anything that has yet been built for a locomotive of this type with the same amount of weight.

It was required in designing the engines that they should not exceed the total weight of 118,000 pounds, with a limiting weight of 90,000 pounds on driving wheels. In order to supply requisite steam for the cylinders, 18 inches by 24 inches, at a working pressure of 190 pounds, it was necessary to employ a boiler of large dimensions, having a grate of sufficient area to afford economical consumption of fuel.

In order to come within the limit of weight, cast steel and pressed steel were used very largely in the construction of the engines. The driving wheel centers, foot plates, bumper knees, guide yoke knees, spring pockets, brake castings, and other minor details were made of cast steel, while pressed steel was used for the boiler front and door, cylinder and steam chest covers, and dome ring. The crosshead is of cast steel of the four-bar guide type with hollow wings and wrist pin. The crank pins are of Krupp crucible steel and are hollow. Each detail of the engine was worked out carefully with a view of reducing weight to the lowest possible amount consistent with a liberal margin of safety.

The locomotives are equipped with the Smith triple expansion exhaust nozzles which are proving very satisfactory in service on the Lake Shore road. From the specifications we take the following:

Gage.... 4 feet $8\frac{1}{2}$ inches
Fuel.... Bituminous coal
Weight in working order.... 118,000 pounds
" on drivers.... 88,000 pounds
Wheel base, driving.... 15 feet
" " total.... 24 feet 9 inches
Cylinders.... 18 by 24 inches
Kind of piston packing.... Dunbar
" " " rod packing.... U. S. metallic
Size of steam ports.... 17 inches by $1\frac{5}{8}$ inches
" " exhaust ".... 17 inches by 3 inches
Kind of slide valves.... Allen-Richardson balanced
Greatest travel of slide valves.... $5\frac{3}{4}$ inches
Outside lap " " ".... 1 inch
Inside " " " ".... $\frac{1}{16}$ inch
Valves in full gear.... $\frac{1}{16}$ inch lap in full gear forward, $\frac{3}{8}$ inch lap in full gear back motion
Kind of valve stem packing.... U. S. metallic
Diameter of driving wheels outside of tire.... 68 inches
Material " " " centers.... Cast steel
Driving box material.... Steeled cast iron
Diameter and length of driving journals.... Front and back $7\frac{1}{2}$ by 9 inches; main $8\frac{1}{2}$ inches diameter by 9 inches
Diameter and length of main crank pin journals.... $4\frac{3}{4}$ inches in diameter by 6 inches
Diameter and length of engine truck journals.... 5 inches in diameter by 10 inches
Kind of engine truck.... 4-wheel, swing bolster
Engine truck wheels.... 33 inches, Paige steel-tired spoke center
Style of boiler.... Extended wagon top
Outside diameter of first ring.... 56 inches
Working pressure.... 190 pounds
Material of shell and firebox.... Carbon steel
Thickness of plates in barrel and outside of firebox.... $\frac{7}{16}$ inch, $\frac{1}{2}$ inch, $\frac{9}{16}$ inch and $\frac{5}{8}$ inch
Firebox.... $95\frac{3}{16}$ by $41\frac{3}{8}$ inches
Firebox, crown staying.... Radial stays, 1 inch diameter
" stay bolts.... Taylor iron, 1 inch diameter
Tubes, material.... Charcoal iron, No. 11 W. G.
" number, diameter and length.... 249 — 2-inch O. D., by 13 feet 3 inches
Heating surface, tubes.... 1,716.6 square feet
" " water tubes.... 14.7 square feet
" " firebox.... 135.3 square feet
" " total.... 1,866.6 square feet
Grate surface.... 27.35 square feet
Exhaust pipes.... Smith triple expansion exhaust pipe
Boiler supplied by.... Two No. 9 Monitor injectors, 1888 style
Tender, weight, empty.... 40,800 pounds
Wheels.... 8 Paige steel-tired spoke center, 36 inches diameter
Journals.... $4\frac{3}{4}$ inches diameter by 8 inches
Wheel-base.... 15 feet
Tender frame.... 10-inch steel channel
Water capacity.... 4,000 U. S. gallons
Coal ".... $6\frac{1}{2}$ (2,000-pound) tons
Total wheel-base of engine and tender.... 47 feet $7\frac{3}{4}$ inches
" length " " " ".... 56 feet $8\frac{1}{4}$ inches

The engine is provided with the American brake on all drivers, operated by air; the Westinghouse automatic air brake on tender and for train, and the Westinghouse air signal; magnesia sectional boiler lagging, Gould coupler on pilot and rear of tender, Cleveland Railway Supply Company's sand blast, Hudson bell ringer, National hollow brake beams, Sherburn 5-inch chime whistle, a water scoop on tender, and two 3-inch Ashton muffled safety valves.

A Court Decision on the Manufacture of Parts of Pressed Steel Car Trucks.

Judge Atcheson, of the United States District Court, last month rendered a decision in the suit of the Fox Solid Pressed Steel Company vs. Chas. T. Schoen and the Schoen Manufacturing Company, the full text of which is as follows:

On and prior to Oct. 10, 1891, the date of the written contract between the plaintiffs, as party of the first part, and the defendants, as parties of the second part, both parties were engaged in the manufacture of center-plates for car-trucks under patents owned by them respectively, the plaintiff at Chicago, Ill., and the defendants at Pittsburg, Pa. By the terms of the contract the plaintiff

granted to the defendants the exclusive right to make center-plates under the plaintiff's patents, and the defendants agreed to pay to the plaintiff seven and one-half per centum of the gross selling price of all center-plates sold by them; and it was stipulated that the plaintiff should have the right to make center-plates "for application to pressed metal truck frames manufactured by it," upon the payment of a named royalty, but should not otherwise engage in the manufacture of center-plates. The contract contains this provision:

"It is further agreed that the parties of the second part will not engage during the life of this agreement in the manufacture of truck frames for moving vehicles or any part of such frames when made of pressed metal."

The present controversy grows out of a difference between the parties as to the meaning of this clause. The plaintiff contends that the clause prohibits the defendants not only from making pressed metal truck frames and parts of such frames, but also from making out of pressed metal any part of a truck frame of whatsoever kind the truck frame may be.

The defendants maintain that the prohibition is against the making of pressed metal truck frames and parts of a pressed metal truck frame.

If the literal reading of the clause were determining, the plaintiff's construction might be entitled to preference. But in the interpretation of a particular clause of a contract the Court is required to examine the entire instrument, and may also consider the relations of the parties, their connection with the subject matter of the contract and the circumstances under which it was made. *Rock Island Railway v. Rio Grande Railroad*, 143 U. S., 596. Moreover, the practical interpretation by the parties of an ambiguous clause of a contract is entitled to great, if not controlling, influence: *Topliff v. Topliff*, 122 U. S., 121; and such practical construction, though at variance with the literal meaning of the clause, will prevail. *District of Columbia v. Gallaher*, 124 U. S., 505. Let us apply these principles here and see with what result.

From an examination of the whole paper of Oct. 10, 1891, it is very clear that its main purpose was to regulate the manufacture of center-plates as between the parties. The clause in question is secondary and incidental. Its introduction at all into the paper would be inexplicable were it not that the plaintiff was engaged in the manufacture of pressed metal truck frames, as the contract itself discloses. That style of truck frame was peculiar, and was of comparatively recent origin and of limited use. The truck in ordnary use was, and is, the diamond truck, 85 or 90 per centum of all the railrocd freight cars in the United States being provided ther e with. The diamond truck frame and the pressed metal truck frame are entirely different constructions.

The plaintiff was not engaged in the manufacture of diamond truck frames. Its business was the manufacture of pressed metal truck frames. The plaintiff was thus interested to avoid rivalry in that particular branch of business, the manufacture of pressed metal truck frames and parts of such frames. The parties entered into the contract with the Fox pressed steel truck frame before them and with reference to the plaintiff's manufacture thereof. To the extent, then, that the restrictive clause secured the plaintiff freedom from competition in the manufacture of pressed metal truck frames and parts thereof, it may be regarded as having a basis in reason. But to carry the provision further would be unnecessary for the fair protection of the plaintiff and unreasonable.

Again, at the date of the contract the defendants were engaged in the manufacture of pressed metal parts of diamond truck frames, and thereafter the defendants continued such manufacture with the knowledge of the plaintiff's principal officials and without objection. This course of manufacture by the defendants was acquiesced in by the plaintiff until about the time of the filing of this bill, on April 18, 1895. It is significant that the bill states that up until February, 1895, the defendants had complied with the terms of the contract. The occasion for the filing of the bill was that in February, 1895, the defendants began making and selling a pressed steel truck bolster. Whether the truck bolster is any part of a truck frame is a contested point. Now, without discussing the evidence, it is enough for me to say that, influenced by the weight of the testimony of the practical experts, and from my inspection of the models, my conclusion is that the bolster is no part of the truck frame. Moreover, no truck bolster is used with a pressed metal truck frame. I am, then, quite unable to see how the plaintiff can justly claim that the manufacture of the bolster is within the prohibitory clause of this contract.

Upon the question of the proper construction of this clause, my opinion, under all the circumstances of the case, accords with the view upon which the defendants insist.

But finally, if, as the plantiff contends, this clause really interdicts the defendants' manufacture out of pressed metal of any part of a diamond truck frame, then the clause, in my judgment, is in unreasonable restraint of trade and not enforcible. *Oregon Steam Navigation Co. v. Winsor*, 20 Wall, 61; *Gibbs v. Baltimore Gas Co.*, 130 U. S., 396, 409. The public interest is much promoted by the use of pressed metal parts in the repair or improvement of diamond truck frames. Now, the plaintiff's business is the manufacture of pressed metal truck frames, and the evidence shows that its manufacturing capacity is fully taxed to meet the demand for that class of truck frames. This prohibitory clause, it will be observed, is without limit as respects place. To enforce it by the injunction here sought would be to deprive the public of the defendants' needed industry, and this, too, without reasonable benefit to the plaintiff. The covenants in restraint of trade hitherto sustained have been those connected with the sale or purchase of a business and its goodwill or some analogous subject matter, where the restraint was no more extensive than was reasonably necessary for the protection of the convenantee. *Nester v. Continental Brewing Co.*, 161 Pa., 473, 481. Here, however, there was no sale or purchase of any business relating to the manufacture of truck frames, and no circumstances existed to justify so sweeping a restriction as the plaintiff claims.

Let a decree be drawn dismissing the bill with costs.

The Decision on Coupler Repair Parts Reversed.

The United States Circuit Court of Appeals last month reversed the decision in the lower courts in the case of the St. Louis Car Coupler Company vs. Shickle, Harrison and Howard Iron Company The lower court had decided that the latter concern infringed the patents of the St. Louis Car Coupler Company in supporting St. Louis coupler knuckles to railroads to replace broken ones. The Shickle Harrison and Iron Company appealed, and from the decision of the higher court in their favor we take the following:

"All the claims of the patents are of the class known as combination claims, in which the several parts of the device are claimed in combination in several different ways. Counsel for the complainant admits that the proof at the trial did not show that the defendant had either manufactured or sold, or offered to sell the complete coupler. He claims, however, and of that fact there is no doubt, that the defendant has manufactured and sold that part of the device, which, in the specification is termed the 'coupling head,' or 'knuckle.' It is accordingly insisted that the manufacture and sale of that part of the device, without the consent of the complainant, constitutes an infringement of the patents.

"The question to be determined, therefore, is whether the manufacture and sale of knuckles for the sole purpose repairing broken couplers, to persons or corporations who had previously purchased such patent couplers from the complainant, and were entittled to use them on their cars—constitutes, in law, an infringement of the patents. The decision of this question turns on the further inquiry whether the purchase of new knuckles by said railroad companies, and the substitution of the same in place of other knuckles that had been worn out or broken, amounted to a reconstruction or a repair of the couplers which were then in use. If the respective railway companies who had bought couplers which were covered by the patents in suit, had the right to rapair them to the extent of replacing knuckles that had been broken, then it is obvious that they had the right to employ the defendant company to make the knuckles for that purpose, and the latter company incurred no liability by so doing.

"The rule is well established that one who purchases a machine or mechanical contrivance, consisting of several distinct parts, which, as a whole, is covered by a patent, has the right, by virtue of his purchase from the patentee, to repair a part of the machine or device which happens to be broken through accident, or which becomes so far worn as to render the machine inoperative, provided the machine, as a whole, still retains its identity, and what is done in the way of rendering it operative does not amount to reconstruction; and provided further, that the part so replaced is not separately covered by a patent.

"The Circuit Court concluded that the manufacture and substitution of new kuckles for those which had been broken, should be regarded as a reconstruction of the car coupler, rather than a repair. It was led to entertain this view, as it seems, because it regarded the knuckle as the chief element of the patented combination; also because the knuckle is unique in form and structure and only susceptible of use in connection with the other elements of the complainant's device. But we are not able to say the substitution of new knuckles for others that had been broken should be regarded as a reconstruction of the coupler.

"The proof shows that it is much more liable to be broken than other parts of the coupling device. It is not wholly accurate to say that the knuckle is the chief element of the combination. Neither can we say that the knuckle is the only part of the coupler which affords evidence of invention.

"In view of the foregoing considerations we think that a purchaser of the patent coupling device should be accorded the right

to replace a broken knuckle without the payment of an additional royalty, provided the drawheads remain intact and serviceable.

"It must be borne in mind, however, that the right to manufacture and sell the knuckle in question, should be confined strictly within the limits stated. We would not be understood as deciding that the defendant company has the right to manufacture the knuckles which form a part of the complainant's device, and to sell them indiscriminately to all persons who see fit to buy them, for clearly such is not the law. We have no doubt that the defendant would be liable as an infringer, if it so happened that the knuckles by it made and sold should be used by the purchasers in the construction of complete couplers such as are described in the complainant's patents. Therefore, if the defendant continues to manufacture the coupling-heads, or knuckles, and keeps them in stock, it must see to it that they are sold for the purpose of repairing the patent coupling device, to persons or corporations who have acquired the right to make and use them for that purpose.

"The decree of the Circuit Court is accordingly reversed, and the case is remanded to that court with directions to dismiss the bill of complaint at the complainant's cost."

No. XXXXX Power Sawing Machine.

The Q & C Company, of Chicago, has recently brought out a new Bryant Saw, called XXXXX, and shown in the annexed cut. It is constructed especially to meet the needs of steel casting works and foundries, where it is necessary to cut off shrink heads or risers of quite large size from engine drivers, gear blanks, propeller blades, and other large and irregularly shaped castings, difficult to handle in the ordinary methods. This saw supplies a recognized want hitherto unprovided for, and is one of the many special machines which the Q & C Company has produced for customers whose needs are peculiar to their own line of work.

The design gives a large unobstructed table for holding the work, the overhanging arm containing all the driving and feeding mechanism, making it a very desirable tool for such work as mentioned above. The saw being 36 inches in diameter allows 15 inches available for cutting, making it possible to cut off a shrink head 15 inches in diameter, or a solid piece of metal 15 inches thick by 24 inches long.

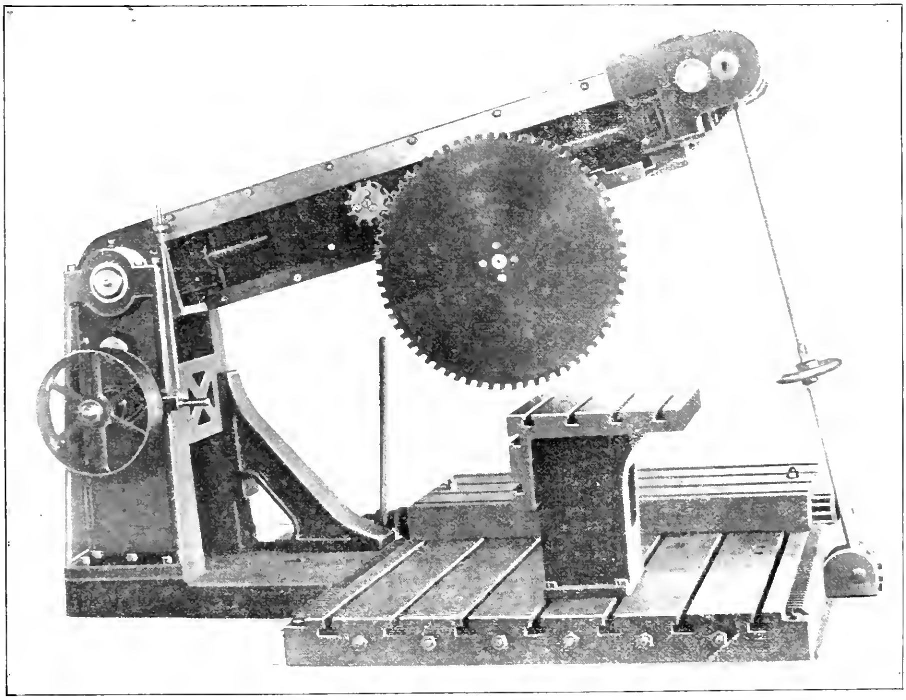
The engraving also shows that the saw-blade overhangs its bearings, or in other words, has one unobstructed face. This allows the operator to place the work as close to the saw as it is possible, and the cut actually finishes the casting, it not being necessary to use a planer or milling machine after the saw has completed its work. One operator can also handle the heaviest cuts.

The illustration does not give an accurate idea of the size of the machine. It weighs nearly seven tons, the metal being distributed in such a way as to give great strength and rigidity. The adjustable sprocket is another advantage over any previous design. The centers between the saws and sprocket are adjusted closer together, as they wear down, doing away with the necessity of enlarged sprockets to compensate for wear. The sprockets are made of cast steel, and are small in size, thereby greatly increasing the leverage.

This first machine was built to the order of the Sargeant Steel Casting Company, of Chicago, whose large and rapidly increasing business made the saw a necessity. In a letter given by them to the Q & C Company, they express the greatest satisfaction in its use, this one machine largely increasing the output of their work. They recently cut off a shrink head 15 inches in diameter in 28 minutes.

The saw is fully guaranteed, and is sent out on the basis of entire satisfaction or no sale.

Further information regarding this or any other saw will be cheerfully sent to all parties interested by addressing the Q & C Company, Chicago, Ill.



The Q & C Company's XXXXX Power Sawing Machine.

All a Mistake.

The reporter that had accompanied the special train to the scene of the wreck hurried down the embankment and found a man who had one arm in a sling, a bandage over one eye, his front teeth gone, and his nose knocked four points to starboard, sitting on a piece of the locomotive, and surveying the horrible ruin about him.

"Can you give me some particulars of this accident?" he asked, taking out his note-book.

"I haven't heard of any accident, young man," replied the disfigured party, stiffly.

He was one of the directors of the company.—*New South Wales Railway Budget.*

Trade Catalogues.

[In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. These are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

HEAT, VENTILATION, DRYING. American Blower Company, successors to the Huyett & Smith Manufacturing Company, Detroit, Michigan. General Catalogue No. 30. 207 pages, 7½x8¾ inches. (Not standard size.)

This book is a fine piece of catalogue work, whether viewed from an artistic standpoint or measured by the value of its contents. It is printed in three colors throughout, on the best of book paper, and nothing could be better than its engravings. The title pages and headings are handsome, and the marginal vignetted half-tones found on nearly every page of text are very pleasing. The wood-cuts by Conant, of Boston, are particularly fine. The cover is of artistic design, on which a number of blowers are represented as delivering great quantities of air across the page, but their united efforts are not sufficient to obscure the title. We give a small facsimile of the design.

The contents are made unusually accessible and are divided into thirteen parts, as follows: Ventilating fans, steel-plate blowers and exhausters, engines, pressure blowers, exhaust fans for shavings and for cotton, steam specialties, hot blast apparatus, heating buildings by the "A B C" fan system, drying of lumber, drying of brick, the "A B C" laundry dryer, drying of leather, tobacco, etc., miscellaneous tables and telegraph code.

The "A B C" disc ventilating fan is given a prominent place in the catalogue. One of the leading features of its construction is the use of a disc on the shaft, to which the blades are attached. There are twelve blades, which the makers claim is four more than in any other fan on the market. The object of the disc is to prevent backflow of air, which will be understood when it is remembered that the speed of the blades at their tips is high and the propulsive force great, and that as the center of rotation is approached both of these factors decrease rapidly and finally become zero. Consequently, when a fan without a disc center is working against a certain pressure any additional speed will not increase the delivery but will simply force the air back between the blades near the center. The disc prevents the back flow, and the company claim in this catalogue that the positive delivery thus secured avoids waste, that the fan can be used against a higher pressure than other makes, and will deliver from one-third to one-half more air with the same power than any other fan built. These fans are made in all styles and for driving by belt or by an engine or electric motor coupled direct, these latter forms being self-contained and very compact arrangements.

The "A B C" steel-plate blowers and exhausters made by the company are also fully illustrated. These are made with full or three-quarter housings, with the discharge opening facing any direction desired and arranged to be driven by belt or direct by engines or motors. One valuable feature of this part of the catalogue, and in fact of all its sections, is that diagrams of the apparatus are shown with letters in the places for dimensions and the value of these letters for each size and type of apparatus fully tabulated. The value of this information will be fully appreciated by engineers and architects.

In the part of the catalogue devoted to pressure-blowers the double-discharge blower is sure to attract attention. The catalogue says that "it has been practically demonstrated that the vane of a fan or blower becomes loaded with air in about one-third of a revolution"; in this blower advantage of this fact is taken and two discharges per revolution are provided for, and it is claimed that twice the delivery of a single-discharge blower is secured. The two discharges are carried to the one pipe and the outside appearance of the blower is not materially different from the single-delivery blowers.

The "A B C" steel plate exhaust fans for handling shavings are so designed that the removal of a few bolts will permit the casing to be rotated to any desired angle in order that the direction of delivery may be changed. The pulley can also be changed from one side of the casing to the other. Thus a fan can be made to fit into any desired location.

In the part of the book devoted to hot blast apparatus the new heater of the company is among the novelties shown. In a heater in which the pipes rise vertically, then run horizontally and extend down into the base again, the outer pipes are always much longer than the inner ones, giving rise to a defect which may be described as a "short circuit"—that is, the steam abandons the long pipes and takes the short route. In the new "A B C" heater the pipes are all made of practically the same length by putting numerous return bends in the inner pipes, and all the heating surface is thus maintained at full value. By a special construction of the base the trouble with "air binding" is also avoided. These heaters are shown in many combinations suited to various kinds of work.

We might describe many other features of the company's output as illustrated in this catalogue, did our space permit, such as the engines, vertical and horizontal, the steam specialties, dust collectors, etc., etc., but we will at present leave these to speak for themselves. We would be guilty of a serious omission, however, if we failed to call attention to the excellent tables of capacities, speeds and horse-powers of fans on pages 24 and 32, in which the figures given are from actual trials, and the tables of heating surface, blower capacity, etc., of hot blast apparatus on pages 116 and 120, inclusive, and the other tables of information found in the book, including those on pages 187 to 196, inclusive. Much of this information is of a character often withheld by manufacturers, and will, therefore, be all the more appreciated.

After thus calling attention to the progressive character of a number of the company's designs, it is needless to say that they are prepared to furnish apparatus for any kind of drying processes, and for heating and ventilating shops, office buildings, churches, schools, theaters, and any and every kind of a structure; in fact, apparatus adapted to all these uses is illustrated in this book. To those of our readers called upon to consider any heating, ventilating or drying problems, this catalogue will be found invaluable.

National Association of Manufacturers.

The date for holding the Second Annual Convention of the National Association of Manufacturers has been fixed for the 26th, 27th and 28th of January, 1897, at Philadelphia, Pa. It is expected that this convention will be one of unusual interest, as the President will submit a report of the first full year of practical work in the lines mapped out by the original convention held in Cincinnati, January, 1895. This report will describe the initiation of practical movement in the direction of the cardinal principles originally adopted by the association, and very gratifying progress in various directions will be noted. It will then devolve upon the convention itself, which will embrace the recorded members holding certificates in the association, to pass upon the work which has been done, and to indicate a policy to be pursued by the President and Executive Committee during the next year, in which year it is confidently expected that existing conditions will enable the association to make vigorous progress.

Dixon's Waterproof Graphite Grease for Signal Work.

A report to the Engineer Maintenance of Way by the Supervisor of Signals on a leading trunk line shows most satisfactory results obtained with waterproof graphite grease, manufactured by the Joseph Dixon Crucible Company, Jersey City, N. J.

At one point, from Oct. 1 to Nov. 28, ¼ pound of the waterproof graphite grease was used on locks, cranks and compensations on the outside and on the machine in the tower. The cost of putting it on was found to be very little more than oil. The same test was made at another point on the road with the same good result. The Supervisor found the waterproof graphite grease better than any other kind of lubricant, as it can be applied quickly and stays where it is put. It is also clean and the water has no effect upon it. Therefore the Supervisor strongly recommends the use of this grease for all the places named above.

As the graphite used in the manufacture of this grease is Dixon's pure flake graphite, the lubricating qualities are easily understood, and if the waterproof qualities are all the manufacturers claim, and the tests seem to demonstrate, its economy and usefulness for all bearing and exposed parts of railway signals are very evident.

Will Adopt the Air-Lift System of Pumping.

We learn that the Wainwright Brewery, St. Louis, is to change its entire system of pumping, having made extensive tests during the past summer as to the most efficient and economical method for its especial needs. It has decided to use the air lift and direct air pressure systems. The air compressor for the low-pressure service, consisting of Halsey pneumatic pumps, will be a Rand cross-compound condensing engine with duplex air cylinders, built by the Rand Drill Company, and of their latest approved type. A second compressor, built by the same company and of special construction, fitted with hooded heads, will take air at initial pressure of about 50 pounds from the main air receiver and compress up to 125 pounds for the air-lift system.

The Pneumatic Engineering Company, 100 Broadway, New York, has the contract for the entire plant.

EQUIPMENT AND MANUFACTURING NOTES.

The Colorado Midland expects to order 200 box cars.

The Ohio Central is said to be in the market for 10 locomotives.

The Wisconsin Central will soon place an order for 200 furniture cars.

The Seaboard Air Line is about to place orders for 12 locomotives.

It is said that the M., K. & T. will soon order a number of locomotives.

The St. Louis & San Francisco has ordered 300 coal cars from the St. Charles Car Company.

The Indianapolis Car Works are building 50 stock cars for the Mather Stock Car Company.

The Brooks Locomotive Works has an order for five locomotives for the Mexican Central Railway.

The Cold Blast Transportation Company, of Kansas City, is asking bids on 100 refrigerator cars.

The Grand Rapids & Indiana is asking bids on about 200 cars, of which about 75 are wanted at once.

The Baldwin Locomotive Works is building seven consolidation locomotives for the Norfolk & Western.

The Chesapeake & Ohio has placed an order for six consolidation locomotives with the Richmond Locomotive Works.

The Universal Construction Company, of Chicago, will build 10 steel flat cars for the Chicago, Lake Shore & Eastern.

The Barney & Smith Car Company is building a dining car, a sleeper and a library car for President Diaz, of Mexico.

The Union Pacific, Denver & Gulf is getting bids on 50 flat cars. Last month it ordered six locomotives from the Baldwin Works.

The Texas Midland expects to order [illegible] flat cars at an early date and six locomotives. It placed one order for 50 cars last month.

The Armour Packing Company has ordered 100 refrigerator cars for the St. Charles Car Company, and expects to place contracts for 200 more.

The Baldwin Locomotive Works have received an order for 25 locomotives, and the Schenectady Locomotive Works 18 locomotives for Japan.

The Bangor & Aroostook has ordered from the Jackson & Woodin Manufacturing Company, Berwick, Pa., 408 flat cars, 185 box cars, and 5 cabooses.

It is stated that the C., C., C. & St. L. Ry. is to build a sample box car of 80,000 pounds capacity, and that the C. & E. I. will construct a 70,000-pound car.

The Chicago, New York & Boston Transportation Company expects to build 125 refrigerator cars at its Elgin shops; 25 of these are now under construction.

The Baltimore and Ohio has placed an order for 1,000 cars with the Missouri Car & Foundry Company. The cars are for the Fairport Warehouse & Elevator Company.

The Rogers Locomotive Works will build 18 Mogul locomotives for the Imperial Japanese Railroad. They will have Latrobe tires, Nathan lubricators, Sellers injectors, Crosby gages and Richardson balanced valves.

The 1,000 Illinois Central cars recently ordered are to be equipped with Chicago rabbeted grain doors, Schoen pressed steel center plates, and Chicago roofs; some of the cars will be equipped with springs furnished by the Chas. Scott Spring Company.

The Kansas City, Pittsburgh & Gulf has placed an order for 200 stock cars, and its programme for 1897 is said to include 1,000 new cars. It will soon be in the market for six locomotives.

The Buffalo, Rochester & Pittsburgh has put into service a mammoth Mogul engine, reported to weigh 184,000 pounds without the tender, and it contemplates ordering seven of these engines.

The Wilmington & Northern has invited bids on 200 gondola cars. The specifications call for Lobdell wheels, Crown bronze or Ajax metal bearings, Butler drawbar attachments, Gould couplers, Westinghouse brakes and Fox trucks.

The American Engine Company, Bound Brook, N. J., has shipped an engine to the Chinese government for use in driving machinery for the coinage of silver.

The Norwalk Iron Works Company, South Norwalk, Conn., have purchased a large piece of ground near their plant, and propose to build on it a one-story machine shop 80 by 300 feet, by which their facilities will be greatly increased.

The Gould Coupler Company has done a large foreign business during the year now drawing to a close, having supplied couplers and vestibule equipments for something over 155 cars on European roads.

The Supreme Court has set the third Monday (18th) in January, 1897, for re-argument of the cases of Westinghouse vs. Boyden, brought from the United States Circuit Court of Appeals upon a writ of certiorari.

The Harrisburg Foundry and Machine Works, Harrisburg, Pa., are rushing a large engine to be shipped to Rio de Janeiro, Brazil. This engine will be placed in the official residence of the President of Brazil, to furnish power for electric lighting.

A press dispatch says that a local syndicate has offered the par value on all bonds and 75 per cent. on the capital stock of $800,000 for the purchase of the Dickson Manufacturing Company's locomotive and machinery plant in Scranton.

The Ramapo Wheel & Foundry Company, of Ramapo, N. Y., recently shipped an order of 80 pairs of 36-inch Snow's boltless steel-tired wheels, and steel axles, to Brazil, for the service of the Paulista Railway. The order also includes 120 loose tires and 120 loose axles.

The A. French Spring Company has an order from the government for large springs to take up the recoil of heavy guns after discharge. Experiments so far made indicate success to a degree which gives promise of an extensive use of springs for this purpose in the future.

It is reported that there is a movement on foot among the manufacturers of woodworking machinery to effect a consolidation of a large number of the firms engaged in this business, and that Mr. T. P. Egan, of the J. A. Fay & Egan Company, and the S. A. Wood Machine Company are largely interested. It is rumored that the consolidation will be largely backed by English capitalists.

The Secretary of the Navy recently awarded contracts for gun forging as follows: Eight sets of 13-inch rifle forgings to the Bethlehem Iron Works, deliveries to begin in 120 days and to be completed in 365 days; six sets of 13-inch and one set of 12-inch rifle forgings to the Midvale Steel Company, deliveries to begin in 160 days and to be completed in 340 days. The price in both cases is 23 8-10 cents per pound.

The new steel ferryboat *St. Louis*, which was built for the Pennsylvania Railroad Company by the Charles Hillman Shipbuilding Company, of Philadelphia, left the latter city Dec. 24 for New York in tow of an ocean tug. The *St. Louis* and a sister boat, the *Pittsburgh*, which is now being built by the Cramps, will ply between New York and Jersey City. They are the twin-screw ferryboats already described in these pages.

Messrs. W. A. Crook & Bros. Company, of Newark, N. J., have in press their 1897 catalogue. It will consist of 130 pages, liberally illustated and showing all the latest improvements in hoisting engines adapted for every purpose.

The catalogue will cover the entire field in this class of machinery. Applications for the new work will be received now by the W. A. Crook & Bros. Company, and copies sent out as soon as possible after publication.

The Railroad Supply Company, of Chicago, has issued an "edition de luxe" of Chicago Day Souvenir, in which is reproduced many interesting photographs of the great sound-money parade in Chicago taken as different divisions of it passed the company's offices in the Owens Building. The souvenir also contains elegant engraving illustrating the company's specialties, such as tie plates, journal-box lifters, Hien car couplers and cattle guards. The whole work is very artistic and pleasing.

Marine engineers can obtain one of the handsomest calendars of the new year free of charge, by addressing The Roberts Safety Water Tube Boiler Company, 41 Cortland street, New York City, and giving their full names and addresses, with name of last vessel on which they were employed. These calenders are a perfect picture and even superior to those issued by the Roberts Company last year. They are sent in a mailing tube. Six cents for postage can be remitted if desired, but is not insisted upon.

The Universal Protective Paint Company, of Chicago, has recently taken out a license for incorporation, and intends soon to move its factory from Lockport to West Chicago, where it will have better facilities for the manufacture of its line of rustless paints, which are so rapidly gaining popular favor. The protective and lasting qualities of "Irown," whether applied to wood or iron, are becoming recognized, which makes a change to larger quarters a necessity. The office of the company will remain at No. 77 Clark street.

The suit of the Morris Box Lid Company vs. The Davis Pressed Steel Company, of Wilmington, Del., for infringement on the pressed steel box lid patents of the former, was decided by the United States Court for the District of Delaware in favor of the Morris Box Lid Company, and the case referred to a Master in Chancery to report to the Court the amount of damages due the complainant. The defendant company is enjoined from making or selling the pressed steel lids covered by the patents on which the suit was decided.

A test of some important and large steel castings for the United States government made last month at the works of the Franklin Steel Casting Company gives strong testimony to the excellence of intelligently manufactured open-hearth steel. The following are the figures:

Tensile strength per square inches	72,000 pounds
Elastic limit " "	46,000 "
Elongation	27 per cent.
Reduction of area	32 "

The Sargeant Company note a decided improvement in the line of their trade specialties, brake shoes. Railroad orders are larger and more frequent. In their steel casting business general machinery trade is better, and the recent results obtained in special cast steel locomotive parts have been so successful that many inquiries have been received and orders entered for crossheads, wheel centers, frames, domes and driving boxes. The Sargeant Compny are certainly to be congratulated for having obtained their present position in the art of steel casting. The field is a large one and the Western railroad and manufacturing trade has long looked for a company on whom they could depend for first-class work.

Passenger Train Service on the Baltimore & Ohio.

Among the improvements that will be made on the Baltimore & Ohio is a radical change in the running of passenger trains. General Manager Greene has been investigating this matter for some time, and contemplates changing the number of cars per train so that they can make better time going up the heavy grades, and as a a consequence will not run so fast coming down. Now that the track has been placed in a first-class condition and new motive power purchased for the passenger trains, Mr. Greene is of the opinion that, by equalizing the weight of the trains, a trip over the Baltimore & Ohio will be made very pleasant.

The track from Chicago Junction to Chicago now ranks as one of the finest in the West. It is laid with heavy steel rail and ballasted with clean gravel, and as there are very few curves on the line the trains are enabled to make high speed with perfect safety.

Every-Day Excursions

To all parts of the world can be arranged for any day in the year, for one or more persons, upon application to any principal ticket agent of the Chicago, Milwaukee & St. Paul Railway. Itineraries carefully prepared for excursions to California, Florida, Mexico, China, Japan and to any part of Europe. Estimates furnished, including all expenses. Tickets furnished for the complete journey. It is not necessary to wait for any so-called "Personally Conducted Excursions." In these days of progressive enlightenment, with the English language spoken in every land under the sun, one does not need to depend upon the services of guides for sight-seeing, but can go it alone or in small family parties, with great comfort and security, and at one's own convenience. Apply to the nearest agent of the Chicago, Milwaukee & St. Paul Railway, or address Geo. H. Heafford, General Passenger Agent, 415 Old Colony Building, Chicago, Ill.

Our Directory

OF OFFICIAL CHANGES IN DECEMBER.

We note the following changes of officers since our last issue. Information relative to such changes is solicited.

Atlantic & West Point.—Mr. R. H. Johnson has been appointed Master Mechanic, with headquarters at Montgomery, Ala.

Baltimore & Ohio.—Mr. E. H. Bankard has been appointed Purchasing Agent, vice Mr. L. J. Buckley, resigned. Mr. F. S. Gannon has resigned as Superintendent of the New York Division, and is succeeded by Mr. J. V. Smith, transferred from the general superintendency of the Trans-Ohio lines.

Boston & Maine.—Mr. Frank Barr has been appointed Assistant General Manager, vice Geo. F. Evans, resigned.

Charleston, Clendennin & Sutton.—John H. Drake; President of the company, died Oct. 21, 1896.

Chicago & Northwestern.—Mr. E. M. Herr has resigned the position of Assistant Superintendent of Motive Power.

Detroit & Mackinac.—Mr. J. D. Hawks succeeds Mr. C. H. Coster as President, and also retains the position of General Manager. Office, at Detroit, Mich. Mr. Geo. M. Crocker, Purchasing Agent is also Vice-President.

Fall River Line.—Mr. Chas. P. Clark has been elected President vice J. R. Hendricks, deceased.

Fort Worth & Denver City.—G. M. Dodge has been elected President, with office at New York. K. M. Van Zandt has been elected First Vice President, with office at Fort Worth, Tex. Morgan Jones has been appointed General Manager.

Hutchinson & Southern.—Mr. W. A. Bradford, Jr., has been appointed General Manager, with office at Hutchinson, Kan.

Long Island.—Mr. E. R. Reynolds, General Manager, and Mr. Geo. C. Hubbell, Purchasing Agent, have resigned.

Maine Central.—On Nov. 30, 1896, the Board of Directors appointed Mr. Geo. F. Evans General Manager in place of Mr. Payson Tucker.

Manhattan.—Mr. Wm. J. Fransioli, Acting General Manager, has been appointed General Manager.

Maricopa & Phœnix & Salt River Valley.—C. C. McNiel has been appointed General Superintendent, vice Mr. E. Shamp, resigned.

Mexican Northern.—Geo. Foster Peabody has been elected First Vice-President and E. M. Shepard Second Vice-President, both with office at New York.

Mobile & Birmingham.—Mr. J. J. Thomas, Jr., has been appointed Master Mechanic, with headquarters at Mobile, Ala.

Morristown & Cumberland Gap.—Mr. Robt. T. Baker has been appointed General Superintendent, with office at Morristown, Tenn., in place of Mr. H. M. Aiken, whose title was General Manager.

New Orleans & Western.—Mr. W. C. Dotterer has been appointed General Manager, vice M. J. Turner, resigned.

New York Central & Hudson River.—Mr. Peter Smith, Master Car Builder at Rochester, N. Y., died Nov. 18.

New York, New Haven & Hartford.—Mr. J. R. Kendrick, Third Vice-President, died suddenly on Dec. 11.

New York, Philadelphia & Norfolk.—G. W. Russell has been appointed Master Mechanic, with office at Cape Charles, Va.

Northern Pacific.—Mr. John Hickey, Superintendent of Motive Power, has resigned because of ill-health, and is succeeded by Mr. E. M. Herr.

Oconee & Western.—Capt. A. E. Hatchfield, President and General Manager, died on Nov. 19.

Philadelphia & Reading.—Mr. Chas. E. Henderson has been chosen Second Vice-President, in charge of freight traffic.

San Antonio & Gulf Shore.—Mr. Henry Terrell has been appointed General Manager, with headquarters at San Antonio, Tex.

Southern.—Mr. Frank S. Gannon has been appointed Third Vice-President and General Manager, with headquarters in Washington, D. C.

Staten Island Rapid Transit.—General Manager F. S. Gannon has resigned, and is succeeded by Mr. J. V. Smith.

St. Louis, Kansas City & Southwestern.—Mr. Dwight Braman has been appointed Receiver.

Vandalia.—Purchasing Agent Mr. C. R. Peddle has removed his office from St. Louis to Indianapolis. The office of General Superintendent is abolished.

Wheeling Bridge & Terminal.—C. H. Coit has been elected Vice-President. H. W. Hayden has been elected Secretary and Treasurer, with office at New York.

Wiggins Ferry.—Mr. S. M. Dolan has been appointed Master Mechanic, with office at St. Louis.

Wiscasset & Quebec.—President Henry Ingalls died last month.

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

FEBRUARY, 1897.

CONTENTS.

THE ALTOONA SHOPS OF THE PENNSYLVANIA RAILROAD.

VIII.

(*Continued from page 4.*)

STORE-HOUSE.

This occupies one end of a building, in the other end of which the offices are located. It is centrally located and accessible from any part of the works. Everything in the store-house is kept in admirable order and a very complete system has been devised for keeping account of the materials received and given out.

The store-room is two stories and the whole inside available space is provided with bins and shelving. A large open space is left in the upper floor, which allows the lower floor to be well lighted. A small wooden crane is provided on the upper floor by which any heavy articles can be conveniently raised to the upper floor. Each shelf or bin is numbered and has a card, which is kept in a tin slide attached to the top of the bin, on which all material received and all given out is entered. None is given out, excepting on orders from the different departments, and after these are filled the order goes to the office and the material is charged to its proper account. The card makes it possible to determine at any time the amount of material which should be on hand in the bin. The store-room is divided into sections, which are devoted to certain classes of material.

PAINT SHOPS.

The painting of freight cars is done in a pair of wooden buildings containing six tracks, each of which will hold from eight to nine cars. There is not much to be said of this building or the work done in it excepting that it is liable to burn up some time.

The paint shop for passenger cars is, however, a model in its way. It is a brick building with a cement floor, and is 420 by 135 feet, and divided into four sections by crosswalls. The building is admirably lighted with skylights and also with windows. The tracks are arranged transversely to the building, and the cars are handled and moved to and from the building by a transfer table, which is operated by electricity. The table is also provided with a capstan, also operated by electricity, with which the cars can be moved to or from the table. Inside of the building, posts are arranged alongside of the tracks, to which movable brackets can be attached and placed at different heights. These carry the planks or scaffolding, on which the men work while painting the cars and preparing them to receive the paint, and dispenses with the use of trestles. In washing cars and rubbing down the different coats of paint, a good deal of water is used. This always makes a paint shop a wet, sloppy and disagreeable place. To avoid this, the shop here described is provided with gutters alongside of the tracks. The distance apart of these gutters, measured between their centers, is equal to the width of a car-body. They are depressed below the surface of the floor, and are connected with the drains, and are covered with iron gratings, and the cement floor slopes toward the gutter. With this arrangement the water used in washing the sides of the cars runs down directly through the gratings and into the gutters and thence to the drains, and any water on the floor also runs into them. The floor is thus always kept free from water.

The shop is lighted with both arc and incandescent electric lights. The latter are attached to long insulated wires connected to the feed wires at the roof. They are then carried down from R and around a pulley P, Fig. 1, attached to a counterweight W and up over another pulley p fastened to the roof, and then downward to the lamp L, which is suspended at this end of the wire. The counter-weight is just heavy enough to balance the lamp, and therefore if the latter is raised or lowered it will stay in any position, or it can be carried into the inside or under the car or any other desired position. The lamps are all protected by wire guards. Suitable iron sinks are placed in convenient positions and are supplied with cold water and steam with which the water can be heated to any desired temperature.

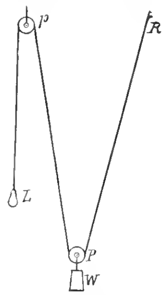


Fig. 1.

The water closets are better than many which are found in hotels, and are kept scrupulously clean, a convenience which is provided for comparatively few workingmen.

One of the sections of the shop is used for a varnish room for sashes, blinds, etc., and is provided with racks, etc., which are required in doing this kind of work.

The whole building is heated and ventilated by Sturtevant's apparatus. Two large fans, about 6 feet in diameter, are provided, which are driven by two 25 horse-power engines. The machinery for heating, ventilating and lighting is located in a building detached from the main shop. The air is drawn by the blowers through a system of steam pipes and is then forced through larger pipes and distributed in different parts of the shop. The drying of paint and varnish is dependent very much on the ventilation of the place where it is exposed. A given amount of air will absorb a certain amount of the volatile portions of paint or varnish, and unless the air is then changed the process of drying will cease or be much retarded. The apparatus here described furnishes a constant supply of fresh, warmed air which escapes from the building through every available crevice and opening, and there goes with it the volatile elements of the paint, which it has absorbed, and the fresh air which enters the room takes up more of the same substance, which is in turn carried away by the escaping air.

The engine-room is equipped with two 50 horse-power Westinghouse engines, two are light dynamos, one incandescent dynamo and one generator to furnish electricity to the transfer table.

The materials used in the paint shop are stored in a building adjoining it.

BOLT SHOP.

A separate building is devoted to the manufacture of bolts and

to cutting the threads on them. This is equipped with a very complete plant of heating furnaces, bolt-making and cutting machines. Both in the bolt and the paint shop nearly all the work is done by piece-work, and those in charge of it give the same reports which were received from all the other shops, that is, that the output of work is greatly increased, and the cost very much reduced thereby, and that it is very popular with the men, who earn higher wages when working by that system than they do when employed by the day.

Another result is that there are no trades unions in Altoona. The men employed there seem to have their social desires satisfied by the church and lodge meetings, and their business enterprise seems to have an outlet through the various building associations which have been organized there.

SCRAP YARD.

The scrap piles of a railroad shop are always interesting and profitable places for observation and study. They are the receptacles of the failures which occur, and the causes of these may be observed here better than anywhere else. This is especially the case where their contents are assorted and classified. A pile of broken couplers will reveal their weak places more effectively than any amount of theorizing or the most abstruse calculation possibly could. The Pennsylvania Railroad have established a technical school of this kind, or what might perhaps be called a mechanical school, which is known as their Scrap Metal Yard, to which all the condemned material from the whole line, east of Pittsburgh, is carried; which suggests that a course in scrap study might be a profitable one in some of the regular technical schools. A professorship of scrapics is suggested.

The object in establishing this yard was to utilize all the condemned material to the best advantage. This is done by assorting it into various kinds, which makes it more salable and it thus commands a higher price. The material when it arrives in this yard is cut to pieces or is separated into its constituent parts, so that it can readily be assorted. The parts which are capable of being used over again are then separated from that fit only for scrap to be reworked. The following is a partial list of the kinds of things which are found in lots of condemned material, but which are often good enough for further service: Bolts and nuts, washers of all kinds, springs, spring-seats, draw-heads, automatic couplers, journal-boxes, center-plates, dead-blocks, brake-wheels, brake-shafts, brake-shoes, brake-beams and hangers, arch-bars, truck-columns, channel-bars, truck-trussrods, draft-castings, stake-pockets, pocket-staples, shafts for drop-bottom cars, corner-bands, steps, brace-pockets, bolster-irons, channel-bars for transoms. Many of these, when taken from condemned or wrecked cars are good for further service. Some of the old timbers taken from cars are used for sleepers in sidetracks of yards, etc., and the old lumber is cut up and used for kindling and firing stationary boilers.

The scrap which cannot be used over again is assorted into the following classes—wrought-iron clippings and punchings, flues and pipes, steel turnings, screw-cuttings, malleable casting scrap, stove and grate scrap, boiler steel, steel axles, iron axles, miscellaneous steel, light smith scrap, selected smith scrap, light cast scrap and wrought-iron turnings. Besides these classes some miscellaneous material such as old barrels, rope, zinc, etc., comes to the yard, all of which is disposed in some way. The amount of the material received which can be used over again is estimated to be about 10 per cent. of the whole. Of course, much of it is in a more or less damaged condition and is bent or otherwise injured, and requires renewal or repair. To do this the yard is provided with a small shop equipped with an engine and boiler, two blacksmith's forges, one power hammer, a big power shears, two bolt cutters, two air pumps for supplying compressed air to an axle tester,* which is located in the iron yard, and to a new air hoist which has just been put up for loading and unloading cars. In this shop all kinds of repairs and renovation is done on the material which is fit for re-use. Bolts are straightened and recut, or, if the thread is spoiled the ends are cut off and shorter bolts are made of what is left. Rods and bar-iron are sheared into lengths suitable for making new bolts: pieces of iron are straightened or otherwise put into condition to fit them for re-use.

A new air hoist of a very excellent design was just being erected at the time the yard was visited. It was of the gallows frame form and extended over several tracks. It is supported on tripodal posts, each made of three steel rails, which are spread apart farther at the base than at the top. The transverse beam is formed of two channel-bars trussed with two sets of truss rods. A vertical air cylinder is carried by a trolley, which runs on the channel-bars. These and the trusses are placed far enough apart so that the air cylinder can be hoisted up between them.

From ten to twelve hundred tons of scrap are received at this yard every month. It is estimated that of this about 150,000 pounds of wrought iron is used over again, and 75,000 pounds of cast iron. Wrought scrap is worth about ⅞c. per pound, and new forgings 2¼. Cast scrap is worth perhaps ⅝, and new castings 1½c. The difference between these prices is what the company makes by re-using the material, which amounts to $2,625 per month, or $31,500 per year, from which, of course, the labor and cost of repair and handling must be deducted. It is not possible to ascertain the profit to the company without knowing accurately the expenses which are incurred in accomplishing the results which have been described. Complete accounts and some systematic book-keeping is required to ascertain how much this department is paying.

THE JUNIATA SHOPS.

It was explained in the first of this series of articles that the Juniata shops, which are located about a mile and a half east of the locomotive repair shops, were primarily intended for the construction of new locomotives. They were designed by Mr. Ely and his assistants during his administration as General Superintendent of Motive Power in Altoona, and it was their aim to have the whole equipment and all the appliances of the latest design and of the most approved and improved kind. They were located on vacant ground with hardly any limitation of space or locality of shops, excepting that the ground had to be graded to conform to the height of the railroad on one side and a street on the other. Before the shops were commenced the most modern plant and appliances for building locomotives in this country and Europe had been carefully studied, and it was the purpose of all concerned to make of the establishment at Juniata a model one.

The arrangement and location of the shops is shown by the plan, which was printed in our June, 1896, number. They are on the north side of the main line of the railroad, the dotted line below the plan representing the dividing line between the grounds occupied by the shops and the main line of the road. The dotted line above, at the top of the plan, is the boundary between the grounds and a street, on which is an electric railroad, by which these shops may be conveniently reached. The entrance-gate and lodge for gate-keeper is indicated just above the office and storehouse, on the boundary line. The approach to the office and shops was originally low ground, but has been filled in and sodded, and laid off with graveled walk and geometrical plots. Inside the gate is a large circular plot bisected by a walk and with a flagstaff in the center. The words, "Juniata Shops" are laid off in large letters on the plot with plants growing in the letters.

The office is a very neat brick building, with a wide arched entrance, and, like all the other buildings, the exterior is perfectly plain, but designed with admirable taste. Its general appearance is shown in the view of these shops published in our June number, page 90, from which it may be seen that it is two stories high and that the rooms are all admirably lighted with large mullioned windows. The office for the clerical force is in the west end of the first floor, and that of the Master Mechanic, Mr. Thos. R. Browne, is back of it. The drawing-room is over these offices. The eastern portion of the first and second floors and basement are occupied by the storekeeper's department. A hand elevator extends from the basement to the second story. The interior is shelved all around and most of the shelving is

* Illustrated in the *American Engineer* of April, 1896.

divided into bins, of which there are about 3,500 in all, which will give some idea of the variety of the material which must be handled and provided for.

BOILER-HOUSE.

The boiler-house is provided with six cylindrical boilers, 75 inches in diameter and 18 feet long, with 94 4-inch flues. The boilers are all provided with Roney mechanical stokers and furnaces.

The furnaces are built back of the end of the boiler, speaking in locomotive parlance, and are lined with fire-brick. The grates are inclined and are operated by machinery, the firing and feeding of coal and the removal of ashes are all done automatically. The grates are divided into two parts longitudinally to the boilers, and the central portions are elevated for the purpose of equalizing the combustion over their whole surface. The stokers are operated by a 5-horse-power Westinghouse engine, and the conveyors for coal and ashes by another 15 horse-power engine of the same make. Experience with this device has shown that it is economical both in fuel and labor.

The boiler-house, being a detached building, is lighted from all sides, and as the coal and ashes is all handled by machinery, the boiler-room is as clean as any first-class machine-shop, and what with perfect ventilation and lighting it is in marked contrast—so far as the comfort of its occupants is concerned—with some of the black holes used as boiler-rooms which are often encountered, and in which men are compelled to work.

The chimney for these boilers is a work of boilermakers' art. It was shown in the general view of the shops, published in our issue of April, 1896, but the engraving is on so small a scale that it does not do justice to the structure. It is of a beautiful graceful outline, the base, which is not shown in the engraving, being curved out so as to be about double the diameter of the chimney, a short distance above it. The height is 124 feet 6 inches, and its diameter at the top is 8 feet. It is lined with fire-brick below for about one-third of its height, and with ordinary red brick above that, all of which rests on a masonry foundation capped with cut stone.

ELECTRIC AND HYDRAULIC BUILDING.

This is just west of the boiler house and is equipped with two Westinghouse 85 horse-power compound and two of 45 horse-power engines. Just south of the Juniata shops the eastbound classification yard is located. This has a large number of tracks, on which eastbound freight cars are classified according to their destination. The tracks have a descent eastward, and the switching or "marshaling" of the cars is done by gravity, the switches being operated by pneumatic power. The compressed air for doing this work is supplied from the building, which is here described, by two Norwalk air compressors, one of which has a steam cylinder 14 by 20 inches, and the other a cylinder 10 by 12 inches. These compressors also supply air for operating hoists and pneumatic machinery of various kinds with which the shops are liberally furnished. A pumping engine by the Dunkirk Engine Company, with a capacity of 100 gallons per minute, supplies water under pressure for operating various kinds of hydraulic machinery in the shops. The water is forced into two accumulators with 14-inch plungers, having 10-feet stroke. A Barr pump, with a capacity of 3,000,000 gallons per day, supplies water to the whole establishment.

The electric machinery consists of one 500-volt U. S. Electric Company's generator, two dynamos by the same company, and one alternating current Westinghouse dynamo for arc lighting. The dynamos are driven by the Westinghouse engines already described, the power being transmitted by Evans' friction pulley. The engine has a large pulley on its shaft and the dynamo has a small one, which is encircled by a number of narrow loose belts, the aggregate width of which is equal to that of the pulleys. The dynamo is arranged so that the pulleys can be brought in contact, the belts acting as a sort of transmitting material between the two pulleys. There are also two incandescent dynamos operated in the same way.

All the exhaust steam from the engines and pumps is carried back to the boiler room by means of a "steam loop," furnished by Westinghouse, Church, Kerr & Company, of New York. A Webster vacuum exhaust steam economizer in the boiler room also helps to reduce the consumption of fuel. This was made by Messrs. Warren, Webster & Company, of Philadelphia.

SMITH SHOP.

This was the next building visited. Near the western entrance a very heavy hydraulic scrap shear, built by the Walker Manufacturing Company, of Cleveland, is located for cutting up scrap to be reworked in the smith shop. This will cut a cold bar of 12 square inches area.

The bolt department is located at the western end of the shops and is brought to the notice of a visitor in entering. The iron is first sheared to the proper lengths on two shears, Nos. 1 and 4, built by the Hillis & Jones Company, of Wilmington, Del. It is then heated in oil heating furnaces illustrated herewith, which were designed by Mr. Browne, the Master Mechanic of these shops.

The various sizes of bolts are headed on one 2½-inch header by the Forsyth Machinery Company, of Manchester, N. H., a 1¼ and a 1½-inch header, by the National Machinery Company, of Tiffin, O., and a 30-ton hydraulic header designed by Mr. Browne and built in the shops. The other equipment consists of one 600 and one 800-pound Merritt Bros. drop hammer, a No. 8 trimming press by the same makers, one Sellers and one Bement 6,000-pound steam hammer. These are used in connection with three regenerative heating furnaces, with 5 by 7 foot beds and one with a 3½ by 4½-foot bed. Besides these large hammers there is one 3,000-pound, two 1,600-pound, four 1,100-pound, and one special frame 1,600-pound hammer built by the Morgan Engineering Company.

The shop is equipped with 24 double forges, each of which has its smoke pipes connected with large horizontal pipes near the roof, which are provided with suction fans run by 5 horse-power electric motors. This draws out the smoke and keeps the shop free from gas and dirt and makes it a fit place for human beings to work in, which cannot be said of some blacksmith's shops which could be named. All the hammers are connected by a steam loop with the boiler-room and the condensed water is thus returned to the boilers.

All bolts and small work in this shop are handled in iron boxes made especially for the purpose, and which it is found facilitates the handling very much. This shop, like all the others at Juniata, is a model in the matter of lighting. The roof is high and the windows large and carried up as near to the roof as was practicable. The proportion of wall area which is glass is much greater than in most shops, especially the older ones. That special form of stupidity which does not recognize the importance of admitting all the light possible into workshops, is very common, but can usually be laid on the shoulders and consciences of architects and civil engineers who design the buildings. It may safely be asserted that if sunshine is excluded, too much light cannot be admitted to a workshop. The time is probably coming when every workshop will be sort of crystal palace with works of art on the walls, and a conservatory in every window. Already landscape gardening and that infallible indication of superior civilization—decent W. C.'s—are now very common.

BROWNE'S HEATING FURNACES.

A very neat and effective form of oil-burning heating furnace, designed by Mr. T. R. Browne, the Master Mechanic, is in use in the blacksmith shops for heating iron up to 3 and 3½ inches diameter. The fuel used is "reduced" mineral oil, or oil from which the kerosene for lighting purposes and the most volatile constituents have been extracted, and which is consequently less liable to ignition or explosion than crude oil is.

As a preliminary to an explanation of the furnace, referred to here, it may be said that for the combustion of the fuel which is used in this furnace various kinds of burners have been tried and are used. The degree of success which has been attained is indicated by the fact that while a pound of the fuel used contains about 21,000 units of heat, only about 11,000, or about half of it,

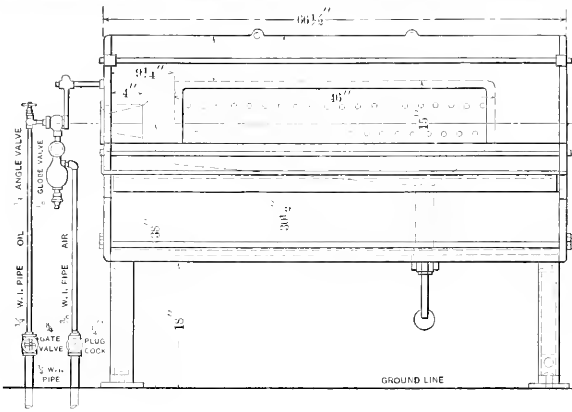


Fig. 2.

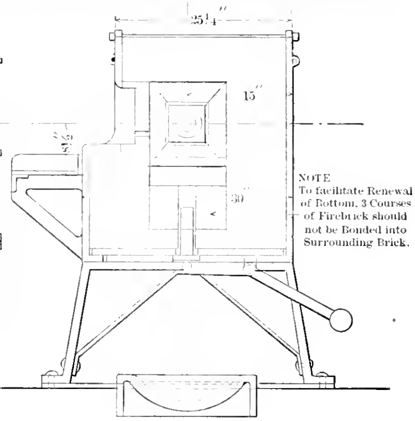


Fig. 3.

Browne's Heating Furnace for Oil Fuel.

is converted into useful work—that is about fifteen pounds of iron are heated per pound of oil, whereas in the furnaces used in the Juniata shops the heating of thirty pounds of iron to a weld-

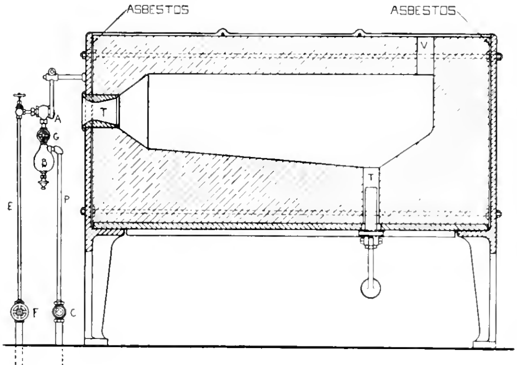


Fig. 4.—Browne's Heating Furnace.

ing heat, per pound of oil, is recorded almost daily, when the furnaces are running steadily.

The general form of the furnace is shown by the engravings Figs. 2, 3 and 4, which represent a side view, a transverse and a longitudinal section respectively. The combustion of the oil is effected by means of an apparatus, shown at the left hand end of Figs. 2 and 4, in which the oil is atomized and converted into a spray or mist by the action of compressed air. Fig. 5 is a sectional view of the atomizer on a larger scale than the other figures. The air is made to combine or commingle with the oil in a jet of a definite form, which flows into a combustion tube or generator T in the end of the furnace; the atomizer A being four or five inches away from the furnace; the jet which is shown by shading lines directed centrally toward the mouth of the tube T, into which the combined air and atomized oil are delivered. On starting up, the oil in this form is ignited inside of the furnace, and at the mouth of the tube, by a lighted bunch of oily waste, which is kept burning until the tube is heated. When this occurs the oil, which comes in contact with the hot tube in a finely divided condition, is converted into a gas at the inner end of the tube. At the same time, the velocity of the jet produces and carries with it into the tube an induced current of air, which supplies the oxygen required for the complete combustion of the oil.

The furnace consists of an external casing of cast iron, bolted together and lined first with asbestos about ¼ inch thick in the inside and then with fire-brick, the form of the interior being as shown in the sectional view. The front of the furnace has a series of fire-bricks with holes, shown in Fig. 2, of the required size and form, through which the iron to be heated is inserted. These holes are made very little larger than the iron so that a comparatively small portion of the products of combustion escapes through the holes around the pieces of iron which are to be heated. The result is that only that portion of the metal which projects into the furnace, and which must be worked, is heated. When the holes in the fire-brick become worn they are used for heating larger sizes of iron.

A vent, V, Fig. 4, is made in the top of the furnace for the

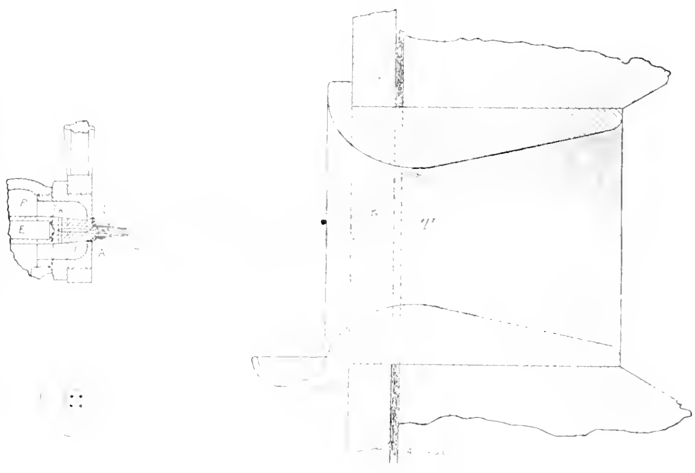
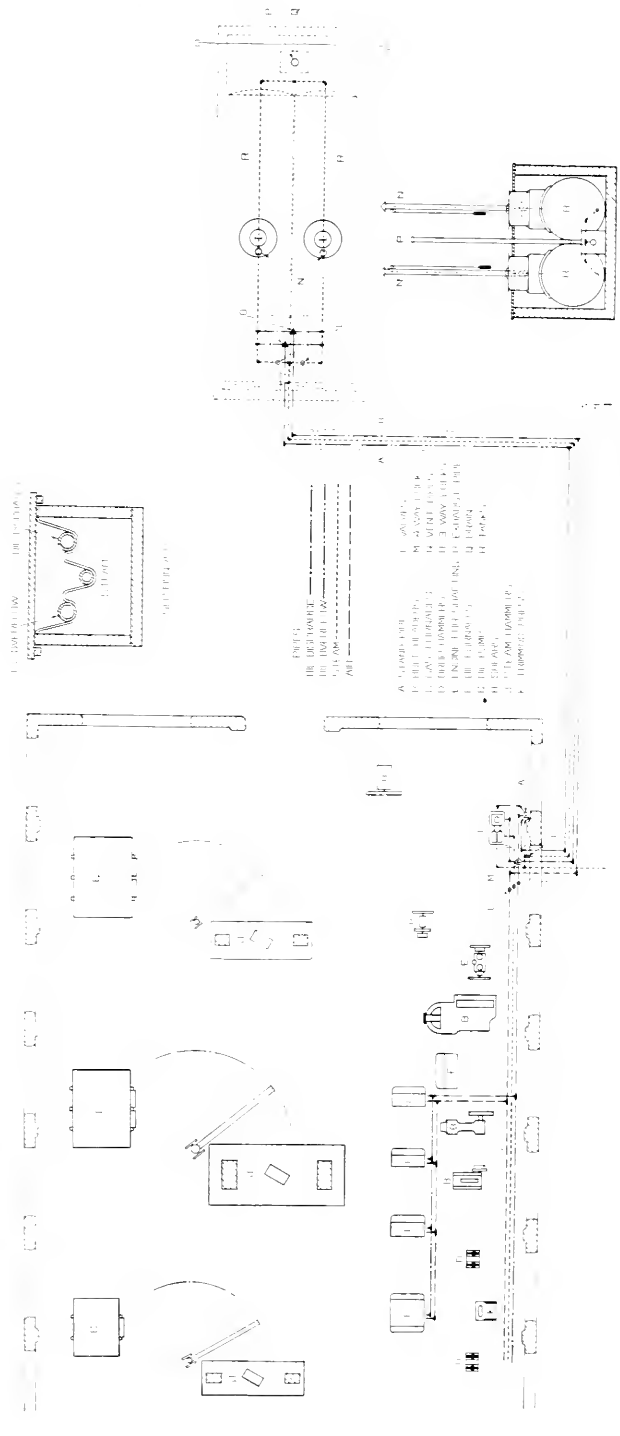


Fig. 5.—Sectional View of Browne's Atomizer.



LOCATION OF BROWNE'S HEATING FURNACES IN BLACKSMITH SHOP AT JUNIATA SHOPS.

escape of the products of combustion and a cinder tap, *T*, shown in Fig. 4, is provided in the bottom of the furnace by means of which the cinders may be drawn whenever they accumulate.

The construction of the atomizer and burner is shown by Fig. 5. Referring to Figs. 4 and 5, the compressed air is delivered to the apparatus by the pipe *P*, which has a plug cock *C*, shown in Fig. 4, at its lower end, by the adjustment of which the pressure of air in the atomizer may be regulated. The air flows first into a trap *B*, which collects any moisture or other impurities which the air may contain. It then passes through a globe-valve *G*, by which the supply is shut off or let on, and from which it enters the atomizer *A*. Oil is supplied by a pipe *E*, the amount of which is regulated by the valve *F*. The oil enters the atomizer through a strainer not shown in the engravings The nozzle, *E*, has four longitudinal holes drilled in it, which are shown by black circles in the lower left hand corner of Fig. 5, and by dotted lines in the view above it. The oil flows through these holes, and at the same time the compressed air enters the atomizer through the space *P*, around the nozzle, and escapes therefrom through the annular opening *I* around it and also through a central hole in it, which is connected to the space *P* inside of the atomizer by the transverse holes *K*. The oil, as it escapes from the nozzle, is thus inclosed in a what may be called a hollow cone of compressed air, which issues from the annular opening around the nozzle, and there is also a core of compressed air inside of the oil. The velocity of the currents of compressed air causes them to converge at *L*, which may be called the neck of the jet, after which the expansive force causes it to expand into a conical form as it flows into the combustion tube, and is shown by the shading. As indicated in Fig. 5, the currents of the two substances remain somewhat apart for a short distance after they are discharged from the nozzle, but their combination is complete after they expand fromthe contracted portion of the jet and when they enter the combustion tube.

The compressed air thus has the effect of dividing up the oil and carrying it with it in a uniform jet into the combustion tube, and, as it acts on the principle of the injector, it takes with it air sufficient for the complete combustion of the oil. As soon as the inner end of the combustion tube, *T*, becomes thoroughly heated, the inflowing jet brings the atomized oil or spray in contact with the heated metal, which at once converts the oil into a gas, and, being mixed with air, the combustion is instantaneous and complete at the inner end of the combustion tube. The constantly inflowing jet impels the burning gas to all parts of the furnace, and thus reaches all the material to be heated. The atomized oil, continuously supplied, provides for a uniform generation of gas,

thus giving with this type of furnace and atomizer all the advantages of the retort system for making producer gas from oil without the disadvantages of a separate expensive installation for the making of that gas, nor the danger attendant upon its manufacture and storage, and also without the expense of outward application of heat to the retorts. No residuum or products of combustion have ever been found in these furnaces, and there is, of course, owing to the completeness of combustion, no smoke or accumulation of gases in the shop. The inflowing air current from the shop, through the tube described, secures to the atomizer or burner ample protection from heat or flame; in fact, the jet of oil and air can be seen in their combined condition until they reach the inside end of the tube in the furnace, where combustion takes place.

The burners are made of very few parts, are thoroughly adjustable, having separate valves for the regulation of the supply of air and oil, enabling the operator or heater to adjust the supply of each, and so prevent excessive scale or the wasting away of the iron which is heated.

The oil and air are not allowed in any way to come in contact with each other, except outside of the burner. There is, therefore, no possibility of gas accumulation or explosion, as is the case with the crude oils when they are allowed to mix inside the burner and form an explosive mixture.

These furnaces have now been in use for over a year in the Juniata shops, and have worked very satisfactorily during all that time. The United States Fuel Oil Equipment Company, in the Bourse Building, Philadelphia, have taken up the furnace and may be communicated with at that address.

A patent has been applied for on this oil burner and is now pending in the patent office.

Fig. 6 is a plan showing the location of the furnaces in the shop in relation to the other plant.

American Passenger Coaches in England.

The South-Eastern Railway of England has recently put in service an entire train of passenger cars of the American type. There are two first-class cars, one second-class, three third-class, and one brake van. The cars are 51 feet 6 inches long over all, 7 feet 6 inches wide, and have Gould vestibuled platforms. They were built by the Gilbert Car Company of Troy, N. Y., except the brake van, which was constructed by the railroad company. The first-class cars seat 26 persons each, the second-class 27, and the third-class 38 passengers each. The first-class cars have revolving chairs, similar to our parlor cars, and the third-class cars have fixed seats, those on one side of the aisle being wide enough for two persons and those on the other seating one person only. The cars are neatly finished, and are lighted by electricity furnished by a motor driven from an axle. Commenting on the advent of this train the *Railway World* (London) says:

"When one comes to reflect upon it, there are really few more awkward situations than that of the traveler who finds himself one of five occupants of a seat on one side of a narrow box, facing five other occupants on the opposite seat, and with so little room to spare that the slightest relaxation of the perpendicular brings him into contact with his neighbors' persons. It is a kind of 'privacy' that may very comfortably be exchanged for a little more publicity, if accompanied by more elbow room. This change is now happily taking place, and for it we are largely indebted to American railway practice. In America the compartment system never found favor. In fact, the opinion that the traveler from the Western world has of our compartments system was well illustrated by the inquiry put to a guard at Charing Cross station by a waiting passenger as to when 'this collection of band-boxes' was to start. The 'band boxes' are now undoubtedly on the decline. The Pullman carriages of the Midland and Great Northern Railways iniated the departure; but for many years they remained the only representatives of the long car in Britain. Eventually there came the Pullman trains on the Brighton Railway, and the Gilbert drawing-room cars of the South-Eastern. In more recent years corridor carriages and dining cars have become familiar on several routes, but it has remained for the South-Eastern, under the enterprising management of Mr. Alfred Willis, to give the public the first genuinely American train. The Brighton Company, it is true, instituted the Pullman train, but this is reserved for first-class passengers, while the train on the South-Eastern is designed for all classes. The new train differs, of course, very largely in detail from American models, but in the main features it is Transatlantic in conception and design. . . . To show how the public appreciate the increased comfort and how little it cares for the loss of 'privacy,' as enjoyed in the old compartment carriages, it may be mentioned that the new train is very largely patronized; in fact on several occasions it has left Charing Cross station with passengers standing in the aisles."

Compounding Compressed Air Motors and Reheating.

Under the above caption *Compressed Air* publishes a translation of a communication by M. Mortier to the Société de l'Industrie Minérale of France, from which we take the following in regard to compounding motors:

"While compound air compressors have already been adopted to a certain extent, the use of multiple expansion has hitherto been limited to a compounding of the motors, the reason of which limitation must be sought in the fact that compound engines cost more than those not compounded, while it is difficult, without warmed intermediate receivers, to restore its initial temperature to expanded air. Instead, however, of compounding each compressed air motor independently, it would be better to compound them mutually, the exhaust air from one series of motors being collected for supplying another series in a pipe under moderate pressure, laid side by side with the high-pressure mains.

"There is, moreover, nothing to prevent various lengths of this supplementary pipe from being connected, first with one another, and afterward with the receiver of the successive compressors, in which case a series of compoundings would be obtained, nothwithstanding differences in the volumes of air exhausted from the two series of motors, and in this manner something akin to the system of electric distribution with three conductors would be effected, without, however, its complication.

"Besides great saving in the first cost of the motors, a mutual compounding would give them considerable elasticity of power without loss in yield, because with two pipes under different pressures, a moderate effective pressure, double or triple, according to the method of connecting the admission and exhaust, may be applied to the same cylinder. Advantage may thus be taken in the same cylinder with normal dimensions of the original economy afforded by low compression, because the possibility of admitting a threefold pressure would permit of overcoming a special resistance or making unusual efforts. In this manner successive stages of compounding introduced into the utilization apparatus would greatly increase the useful effect of moderating or governing, by permitting the dimensions of the motors to be reduced and the wire-drawing of the compressed air in the cylinder to be diminished."

The following suggestion regarding the possibilities in reheating is worthy of attention:

"While the other agents of power transmission, such as electricity and water under pressure correspond with a strictly defined amount of energy available, compressed air, in addition to the amount of work which it is capable of giving out at a constant pressure and at the surrounding temperature, carries with it a credit, theoretically unlimited, for transforming into power the artificial heat which may be communicated to it; and this transformation is effected with so high a thermal yield that the supplementary work thus obtained is almost gratuitous.

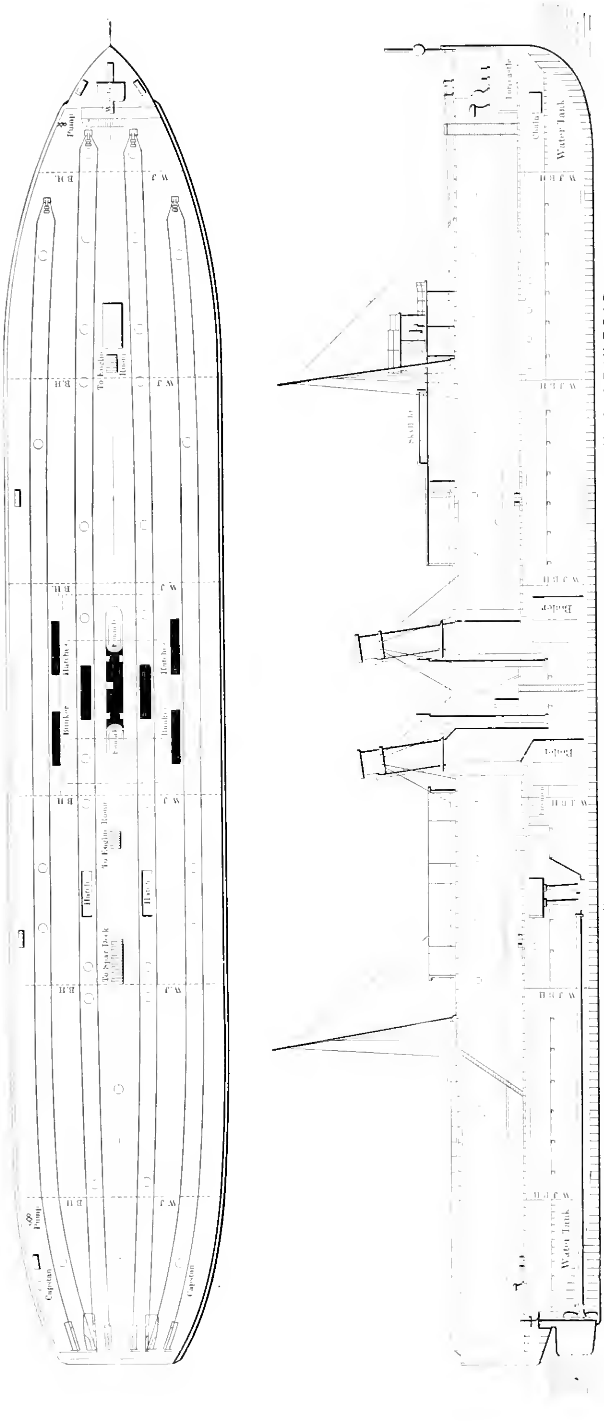
"In other words, the purchaser of a given weight of compressed air acquires at the same time the right of obtaining, without complication of any consequence, and with a very slight expenditure of fuel, an artificial quantum of energy at least equal to that of the natural energy imparted to it directly.

"This special faculty added to absolute elasticity of speed, both of the compressors and the motors, and also to the possibility of regulating or storing up compressed air, constitutes an individual feature of the highest importance, which may often justify a preference being given to this agent of power transmission."

The Record of a Flyer.

The Richmond Locomotive Works have published a handsome brochure entitled "A Record of a Flyer" on the Seaboard Air Line. This flyer was a directors' special, consisting of two heavy officers cars and one regular coach, hauled by a 19x24 eight wheeled engine, one of seven built for the road by the Richmond Locomotive Works in 1895, from the designs of Mr. W. T. Reed, Superintendent of Motive Power. The run was made November 21, 1896, between Weldon, N. C., and the Portsmouth (Va.) shops, the distance of 76.8 miles being covered in 72½ minutes. This time is subject to a deduction of about five minutes, lost by reducing speed to comply with city ordinances at Seaboard, N. C., Franklin, Va., and Suffolk, Va., and in crossing Nottoway River, at which point a new bridge is under construction; this would leave the actual running time 67½ minutes

The engine is No. 540 and weighs 112,000 pounds, of which 75,000 pounds is on the drivers. The boiler is 58 inches in diameter, has 1,732 square feet of heating surface, 17.5 square feet of grate, and carries 180 pounds pressure. The drivers are 68 inches in diameter. The highest speed reached was 87 miles per hour.



THE NEW CAR FERRY "PERE MARQUETTE" FOR THE FLINT & PERE MARQUETTE RAILROAD.

Built by F. W. Wheeler & Co., West Bay City, Mich.

The New Car Ferry "Pere Marquette."

The latest addition to the fleet of car ferries on the great lakes is the boat *Pere Marquette*, built by F. W. Wheeler & Company, of West Bay City, Mich., for the Flint & Pere Marquette Railroad. It is a steel boat driven by twin screws, and is for service on the route across Lake Michigan between Manitowoc, Wis., and Ludington, Mich. The distance is about 53 miles.

In the accompanying illustrations we show a plan and a longitudinal section of the boat kindly furnished us by Mr. S. T. Crapo, general manager of the railroad company. The boat is 350 feet long, 56 feet beam, depth below main deck 19½ feet, and 36 feet 3 inches deep from upper deck to floor. It has four tracks and has a capacity of 30 cars. These, if fully loaded 60,000 pound cars, would weigh 1,350 tons. Carrying this load and 200 tons of fuel the draft of the ferryboat is 14 feet.

The vessel is entirely of steel and strongly built. The hull has six watertight transverse bulkheads dividing the hull into seven compartments. If any two of these compartments should be filled with water the steamer can still carry its load. The forward plating is ⅝ inch thick and is double for a distance of 60 feet back of the stem. It is also double on the between decks beam strake. The side channels are 12 by 3 inches, and are spaced 24 inches centers amidships narrowing to 14 inches forward. Channel beams, thoroughly braced horizontally and vertically, extend across the hull, about midway between the floorand main deck. These are near the water line, and serve to resist the pressure of the ice encountered in winter service. About 2,700 tons of plates and angles were used in the construction of the hull.

The boat is propelled by twin screws 11 feet in diameter, driven by compound engines with cylinder 27 and 56 inches in diameter and 36 inches stroke. These engines develop a maximum of 3,500 indicated horse-power, and will give the boat a speed of 15 miles per hour. Steam is furnished by four cylindrical boilers, each 15 feet 3 inches in diameter and 12 feet long, and carrying a working pressure of 130 pounds per square inch. Each boiler has four furnaces. The boat's equipment of machinery includes a complete modern outfit of steam windlass, steam capstans, steam steering gear, etc., also an electric light plant and a 16-inch search light.

The deck houses are of wood. Besides the pilot house, there are ten staterooms forward, while aft there is a dining-room and kitchen, and quarters for the crew. The sleeping accommodations are sufficient for 25 passengers.

The boat presents none of the ungainly appearance that one is apt to associate with a car ferry, and altogether it is considered to be one of the finest examples of this class of steam vessels.

The Pullman Car Company has reduced its fares on the line between Cincinnati and Hannibal, Mo., via C. H. & D., I. D. & W., and Wabash roads. The seat fare in chair cars is now $1 and the distance is 417 miles.

The Effort to Establish a Standard 60,000-Pound Box Car.

The Ohio Falls Car Manufacturing Company, which inaugurated the movement among car builders to establish a standard box car, which it was proposed to follow in building for small roads or others who do not furnish drawings with their orders for cars, informs us, that the movement has met with much greater support than was anticipated. Regarding the matter they write:

"This support, however, is not in the nature of official co-operation by the railroad clubs, but in the favorable expression individually of a larger number of prominent railroad officials and car builders. It is the judgment of a majority in interest that the movement should have a wider scope then first intended and should embrace every important part left undecided by the forthcoming M. C. B. Convention in June. It has therefore been decided to continue the development of this plan until the convention announces its decision, and add to the standards then adopted an agreement covering as many parts as the car builders will unite upon.

"We enclose blue print summarizing the standards of the companies that have sent in reports to date. The variations are inconsequential and yet sufficient to prevent interchangeability, emphasizing the desirability of accomplishing the object in view."

DIMENSIONS PROPOSED FOR A STANDARD BOX CAR.

	Barney & Smith Car Co.	The Terre Haute Car and Mfg. Co.	The Elliot Car Co.	The Ohio Falls Car Mfg. Co.	United States Car Co.
Clear inside length	33 ft. 0½ in.	33 ft. 6 in.	34 ft.	34 ft.	33 ft. 4¼ in.
" " width	8 ft. 3½ in.	8 ft. 4 in.	8 ft.	8 ft. 2¼ in.	8 ft. 1¼ in.
" " height	7 ft. 2 in.	6 ft. 9 in.	6 ft. 11 in.	5 ft. 8¼ in.	7 ft. 0¼ in.
Door opening	5 ft.	5 ft.	6 ft.	5 ft. 6½ in.	5 ft. by 6 ft. 6½ in.
Center to center of center ties	6 ft. 10½ in.	4 ft. 6 in.	6 ft. 9 in.	6 ft. 3 in.	8 ft.
Section of side sills	5 in. by 8½ in.	5 in. by 9 in.	5 in by 10 in.	5 in. by 9 in.	5 in. by 9 in.
" " center sills	5 in. by 8½ in.	5 in. by 9 in.	4 in. by 10 in	5 in. by 8⅓ in.	5 in. by 9 in.
" " intermediate sill	5 in. by 8½ in.	4 in. by 9 in.	4 in. by 10 in.	5 in. by 8½ in.	5 in. by 9 in.
" " side plate	3½ in. by 7 in.	4 in. by 6 in.	....	3 in. by 6 in.	3 in. by 8 in.
" " end plate	3½ in. by 12 in.	....	....	3½ in. by 12 in.	3 in. by 13 in.
Height of lining	3 ft. 6 in.	3 ft. 6 in.	4 ft.	4 ft.	2 ft. 6 in.
Truss rod's diameter	1¼ in.	1⅛ in.	1⅛ in.	1⅛ in.	1¼ in.
" " end	1⅜ in.	1⅜ in.	1⅜ in.	1⅜ in.	1½ in.
Wheel spread	4 ft. 10 in.	5 ft.	5 ft. 6 in.	5 ft.	5 ft.
Upper arch bar	4 in. by 1¼ in.	1¼ in. by 4 in.	1¼ by 4 in.	1⅛ in. by 4 in.	1¼ in. by 4 in.
Lower " "	4 in. by 1⅛ in.	⅞ in. by 4 in.	1⅛ by 4 in.	1 in. by 4 in.	1 in. by 4 in.
Tie bar	4 in. by ⅝ in.	⅝ in. by 4 in.	⅝ in. 1 in.	½ in. by 4 in.	⅝ in. by 4 in.
Set of upper arch bar	....	....	....	5 in.	5 in.
Set of lower arch bar	....	....	....	12 in.	13 in.
Set of tie bar	....	....	....	1 in.	2¾ in.
Diameter of column bolts	1⅜ in.	1⅜ in.	1¼ in.	1¼ in.	1¼ in.
" " oil box "	1⅛ in.	1⅛ in.	1 in.	1 in.	1⅛ in.

We give herewith the tabulated statement contained in the blue print mentioned. It will be evident from a perusal of these figures, few as they are, that the differences in dimensions existing to-day are not vital, and that small compromises between those interested would result in the use of one design. As we said editorally two months ago, there is no good reason why the movement should not result ultimately in a standard car adopted by the Master Car Builders' Association and the railroads, as well as the car builders. This outcome of the movement is greatly to be desired, and we hope to see it achieved. The determination to continue the work and include in it many parts of the car not found enumerated in the above list, is a step in the right direction, and the announced intention to incorporate in the standard every detail standardized by the M. C. B. Association shows that there is no intention on the part of any one to usurp the privileges or duties of the association.

Trial of the Steam Turbine for Marine Propulsion.

The torpedo boat *Turbinia*, built at Wallsend by the Marine Steam Turbine Company, Limited, for the purpose of testing the application to marine populsion of the Parsons' steam turbine, went for a trial trip on December 15 Several most successful runs were made, and the very high speed of 29.6 knots was attained over the measured mile. It is believed that this is a speed greatly in excess of anything that has ever been previously accomplished by a vessel of the small dimensions of the *Turbinia*, which is only 100 feet in length, 9 feet in beam, and has but 42 tons of displacement when fully loaded. Indeed the speed already attained upon this preliminary trial trip by this small boat nearly approaches the maximum limit of speed so far attained by the largest torpedo-boat destroyers, which have more than twice her length and about six times her displacement. Having regard to the fact that this was only a preliminary trial, and that it was shown that there was a considerable reserve of power still to be called upon, it is anticipated that a still higher speed materially in excess of the remarkable result already attained will eventually be realized. In any case, the obtained results as recorded above are such as cannot fail to be of extreme interest to all naval architects and marine engineers. During the trial, there were present on board the vessel, among others, the Earl of Rosse, Chairman; the Hon. C. A. Parsons, Managing Director, and Mr. A. A. Campbell, Swinton, Director of the Marine Steam Turbine Company.—*The Steamship.*

Car Ventilation on the Pennsylvania Railroad.

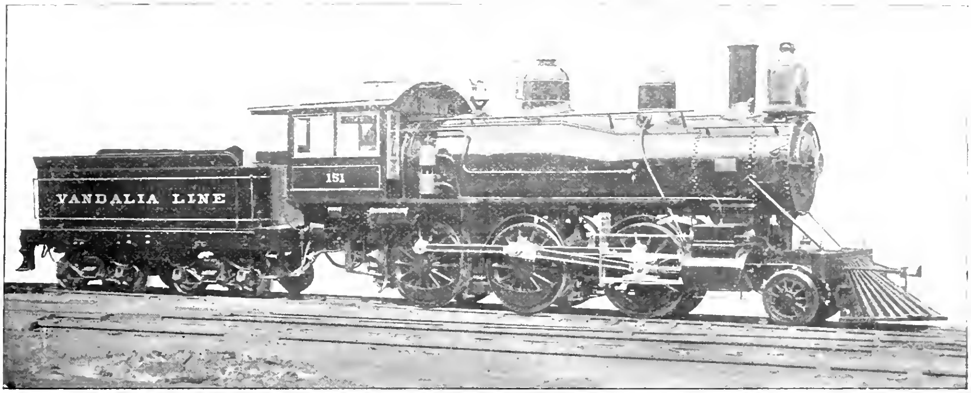
Dr. Chas. B. Dudley, chief chemist of the Pennsylvania Railroad, gave an interesting lecture on car ventilation before the Franklin Institute last month. A brief summary of it is given in the Philadelphia *Ledger*, from which we take the following:

The Pennsylvania Railroad has been making a long and expensive series of experiments. No problem is so fraught with difficulties as the ventilation of passenger coaches. The whole question of ventilation, whether of public buildings or private dwellings, is but little understood, and there is a great variance in the views of distinguished architects on the subject. The conditions environing the ventilation of moving railway coaches with small cubic contents in proportion to the number of people, with the necessity for keeping out cinders and dust, and at the same time keeping an equable and agreeable temperature in the cars, rendered the problem one of exceeding difficulty.

The first point definitely determined was that the heating and ventilation of the car must go hand in hand; they could not be separated. The next point is to know how many cubic feet of fresh, warm air must be supplied to each person to constitute good ventilation. Conclusions drawn from experiments made in England show that a space is well ventilated when a person coming into it from the outside air detects no odor. Experiment has shown that the carbonic oxide naturally in the atmosphere, which is the deleterious element, amounts to 4 cubic feet in 10,000, and that by the addition of 2 cubic feet more of carbonic oxide, an odor may be detected. This, then, is the measure of ventilation. An average person gives off 6-10 of a cubic foot of carbonic oxide each hour. With this data it is figured that 3,000 cubic feet per person of pure air must be supplied to ventilate a car, and for a car containing 60 persons this means that the total air in that car must be changed every 80 seconds, or 45 times an hour. It would be impracticable to do this and heat the air from zero to 70 degrees.

The experiments made by the company had been based upon supplying half of the 3,000 cubic feet per passenger, and to heat 12 cars, which is about the size of the trains on the main line, would require about 3½ per cent. of the steam which the locomotive could produce.

Experiments have been made with a system of steam pipes running the whole length of the car on each side, in the same place as the heat-box in the present system, but just under the floor. The



MOGUL LOCOMOTIVE FOR THE VANDALIA LINE.

Built by the Pittsburgh Locomotive Works. Mr. W C. Arp, Superintendent of Motive Power.

air is led from the hood near the roof, at the end of the car, as before, to a box under the steam pipes, and rises through openings into the box containing the pipes, from which it passes into the car through openings in the floor. These apertures are 4 inches long and $1\frac{1}{4}$ inches wide and 4 inches apart. The ventilators must have the same capacity for discharging the air, and 20 of these are distributed along the roof of the car. The result obtained with a car so equipped was a circulation of 90,000 cubic feet of air per hour. The snag which was struck was that, with such a supply of air, the temperature of the car was only 40 degrees, when the outside air was zero.

The company had reached a point where it could furnish one half the theoretical amount of air required, but could not warm it in zero weather. It was thought that during extreme weather a little poorer ventilation might be endured for a month or two. The question of smoke, cinders and dust had not been touched thus far.

The problem now stands thus: It is possible to get a great deal more air into a car than by any other known system: if passengers could content themselves with 20,000 or 30,000 cubic feet instead of 90,000 per hour, the air could be supplied properly heated and the system could be put on cars at once. On the other hand, there are 2,500 passenger cars to be equipped, and it is a very expensive operation. It has, therefore been deemed advisable to experiment further and exhaust the subject before making any change.

New Mogul Locomotives on the Vandalia Line.

Some months ago the Vandalia line received some new mogul locomotives from the Pittsburgh Locomotive Works, and through the courtesy of Mr. W. C. Arp, Superintendent of Motive Power, we have received the diagram and photograph given herewith. In a letter to us regarding them, Mr. Arp says: "These engines are used in freight service on the main line between Indianapolis and St. Louis. There are practically three divisions, but our intention is to run them 165 miles from Terra Haute to St. Louis, and 75 miles from Terre Haute to Indianapolis. On the division between Terre Haute and Indianapolis the engines are rated at 950 tons; on the Western division, 1,000 tons. The performance of these engines is very satisfactory."

The engines have 20 by 26 inch cylinders and driving wheels 62 inches in diameter. These wheels are of a more suitable diameter for good freight work than smaller ones would be, when the cylinders are large enough to turn them, and will reduce the cost of maintenance. The boilers have a total of 2,129 square feet of heating surface and the grate area is 30.6 square feet. Some of the leading dimensions are given in the outline sketch and others will be found below:

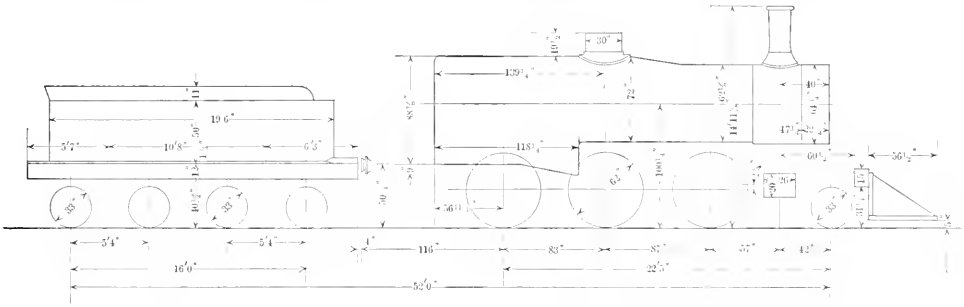


Diagram of Vandalia Locomotive.

Type	Mogul
Fuel	Bituminous coal
Gage of track	4 feet $8\frac{1}{2}$ inches
Total weight of engine in working order	142,000 pounds
" " " " on drivers	127,000 pounds
Driving wheel base of engine	14 feet 2 inches
Total " " " "	22 feet 5 inches
" " " " " and tender	51 feet 8 inches
Height from rail to top of stack	14 feet $11\frac{5}{8}$ inches
Cylinders, diameter and stroke	20 by 26 inches
Piston rods	Steel, $3\frac{1}{2}$ inches diameter
Type of boiler	Extended wagon top
Diameter of boiler at smallest ring	62 inches
" " " " back head	72 inches
Crown sheet supported by one-inch radial stay bolts, 1 inch diameter, spaced four inches from center to center.	
Number of tubes	318
Diameter " "	2 inches
Length of tubes over tube sheets	12 feet
" of firebox, inside	108 inches
Width of " "	41 inches
Working pressure	185 pounds
Kind of grates	Cast iron, rocking
Heating surface in tubes	1,950 square feet
" " in firebox	179 " "
Total heating surface	2,129 " "
Grate area	30.6 " "
Diameter of driving wheels outside of tires	62 inches
" and length of journals	$8\frac{1}{2}$ by 11 inches
" of engine truck wheels	33 inches
" and length of journals	6 by 10 inches
Type of tank	Level top
Water capacity of tank	4,000 United States gallons
Fuel " " "	280 cubic feet
Weight of tender with water and fuel	81,400 pounds
Type of brakes	Westinghouse American

The Southern Union Station in Boston.

The plans of the Southern Union Station, to be built in Boston, Mass., were approved by the State Railroad Commission on January 4, and work upon this important terminal will begin at once. The new terminal is to be constructed by the Boston Terminal Company, which is composed of officers of the New York, New Haven & Hartford, and the Boston & Albany railroads, and will result in the abandonment of four stations in the southern part of the city.

Boston has a union station on the north side of the city, occupied by the Boston & Maine, Boston & Lowell, and Fitchburg railroads, but at present the lines entering the city from the south have separate terminals, as follows: New York, New Haven & Hartford (Providence Division), Park Square Station; New York, New Haven & Hartford (Old Colony Division), Kneeland street; Boston & Albany, Kneeland street; and until its absorption the New England road used the station on Summer street. The new terminal is to be erected on the ground of the New England terminals, and with its yards will cover 40 acres, 30 acres of which is already in the possession of the Terminal Company. When completed, which it is expected will be within 18 months, there will be only two passenger stations in Boston instead of the four in use at present.

Fig 1.—Persective View of Southern Union Station, Boston.

The bill for the New Southern Station passed the Legislature in the spring of 1896, and since then the trustees of the Terminal Company have been in constant consultation with their architects and engineers perfecting the scheme for the new terminal. Many different methods have been carefully considered by them, and the advantages of each method have been developed as far as possible. They now feel that they have selected from all the methods under consideration those which will give the best practical results. Important changes have been made in the arrangement of tracks and platforms since the plans were presented last spring, which have greatly increased the train capacity of the terminal. At that time the problem was to show the adaptability of the locality for station purposes, but that point being conceded, the problem changed to one of best development of the territory.

It has long been recognized that the suburban, or commutation, passenger traffic of the steam railroad is different in character from the passenger traffic which goes beyond the commutation points. The suburbs of Boston are numerous and contain a large population, thus making the handling of the suburban traffic an important problem. At the present stations whose traffic is to enter the new station about 25 tracks are used for passenger service, and they are even now evertaxed. The stub-track system in the new station provided 28 tracks, hardly more than the number now needed and offering no expansion for the future large increase of suburban traffic that already comprises two-thirds of the whole. The switch systems at the point where the station tracks branch out from the main tracks are generally congested after serving 20 or more tracks. At the present southern and western stations there are in the neighborhood of 3,500 switch movements through these switch systems in a day of 18 hours. To adequately provide for the suburban traffic, it was therefore decided to separate it almost wholly from other service. This is accomplished by having tracks on two levels, the upper level with stub-tracks for through trains, and the lower level with a loop terminal for suburban trains.

The general plan of the terminal is to be seen in Fig. 1, and the perspective of the building is given in Fig. 2. The lower level loop is shown in Fig. 3. As arranged, the steam railroad stub-track terminal station is left as usual, with the platforms five feet above the street grade, but with all the platforms reached without the use of steps. This level is devoted to the usual trains which go beyond commutation points and such suburban trains as it may be desirable to keep on that level. The lower level is to be used exclusively for suburban trains which may be run with electricity for a motive power, or any other suitable motive power which avoids the nuisance of steam, gas and smoke.

The upper floor will be provided with 28 stub-tracks, so arranged in connection with the switches to the main-line tracks of each road that all outgoing trains may leave from one side of the train-house and all incoming trains enter on the other side of the house, or if preferred, the train-house may be divided into two grand divisions, one of which shall be used by the roads going out over the Providence Division and the Boston & Albany Railroad, and the other by the trains of the New England and Old Colony. These 28 tracks will hold about 350 passenger cars when completely filled. There will be seven platforms the entire lengthof the train-house dovoted exclusively to the trucking of baggage and express matter altogether out of the way of the passengers, and at the end of these trucking platforms there will be baggage and express truck elevators to a subway under the tracks connecting with the baggage-room and the express buildings.

The lower floor (see Fig. 3) will be served with two loop tracks which connect with the main tracks by means of the depressed yard tracks seen in Fig. 1 between the main tracks and Dorchester avenue. These tracks join the main tracks at points about one-half a mile from the station, the grades and curves being suited to light suburban rolling stock. The loop tracks enter the train-house at a grade about 17 feet beneath the stub-tracks, and as they enter they spread to pass on either side of a large island platform between the tracks. This is designed to be the loading platform, so that outgoing passengers can go to the one platform for any suburban train using the station. The two outside platforms will be for unloading the passengers from incoming trains. These platforms are of such length that 14 trains of three cars each may stand next to them, seven on each track. It is said that if it becomes necessary to send out one train a

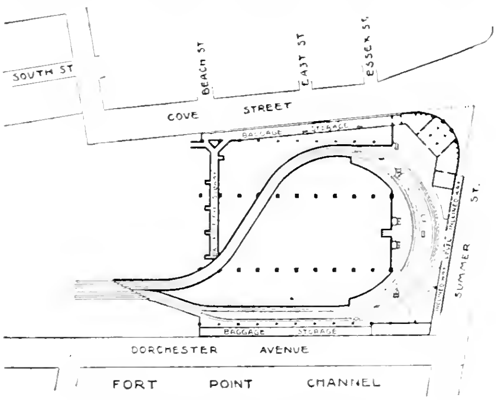


Fig. 3.—Plan of Loop Tracks on Lower Level, South Union Station, Boston.

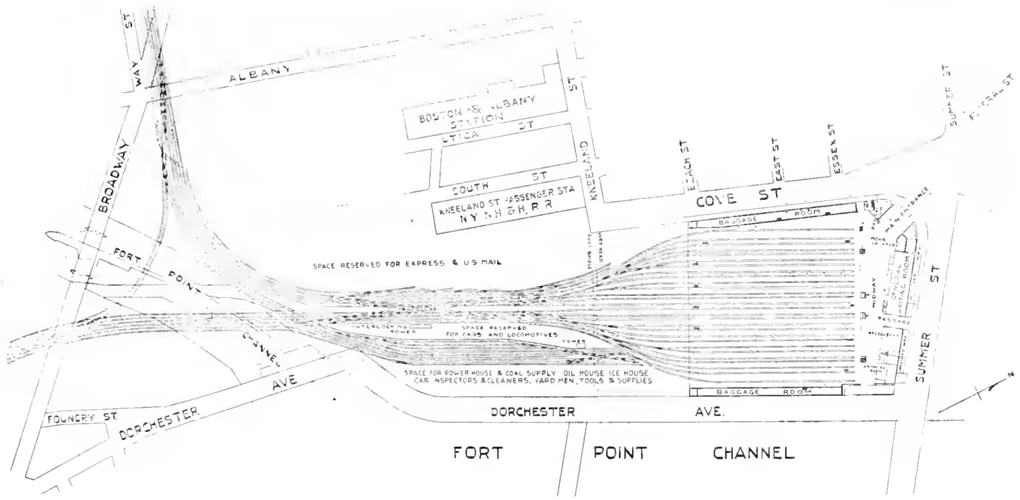


Fig. 2.—General Plan of South Union Station, Boston.

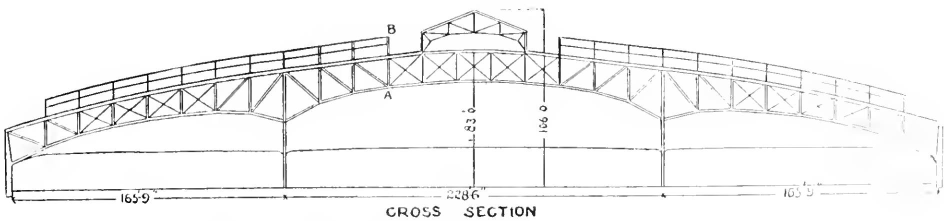
minute it can be done, and then each train will remain in the station four or more minutes for unloading and loading. This means upward of 2,000 trains in and out in each day of 18 hours upon these two tracks alone, which is five times as many as are at present run in the suburban service. The platform area devoted to this service will allow an assembling of about 25,000 people at one time.

These two floor levels are about equal in vertical distance above and below the level of Summer street, and all passengers may go to and from the street without the use of stairs to either floor.

The switch system will be operated through the pneumatic system of interlocking. The power plant for the whole terminal will be a large one, and will be located on the Dorchester avenue side of the station.

general offices, and also to restaurant-rooms in addition to those provided on the first story. The third, fourth and fifth stories will be occupied by the offices of the several railroad companies forming the Terminal Company. In addition to the main entrance access to the trains of the upper level is provided from Cove street, Summer street and Dorchester avenue. The passage on the Summer street side is 44 feet wide, while that on Cove street is 25 feet.

The general waiting-room will be 65 by 225 feet, and will extend up two stories, being about 28 feet high to the upper side of the ceiling beams, these beams being 4 feet deep. The ticket office, 12 by 92 feet, will have 24 ticket windows, and will extend along the side of the waiting-room between the midway and the waiting-room. At the end of the waiting-room, near the main



CROSS SECTION

Fig. 4.—Section Through Train Shed, South Union Station, Boston.

The head-house will contain offices for all the railways entering the station. At the corner of the building at the junction of Summer and Cove streets there will be a main entrance 92 feet in width. The curved front at this point is 228 feet long, and from it the main building extends 324 feet on Summer street and the same distance on Cove street. Beyond the main building on Cove street the baggage-room will extend a distance of 350 feet. On Summer street a two-story building will extend from the main building to the corner of Dorchester avenue, and along the whole frontage on this avenue. The first floor on the Dorchester avenue side will be devoted to a carriage concourse and to baggage, while the second floor will be occupied by rooms for conductors, trainmen, stores, etc. On Summer street the building will be set back 20 feet from the lot line to admit of inclined ways down to the suburban level, and these ways and the sidewalk will be covered by an awning of glass and metal. The first story and basement of this main building are to be devoted entirely to railroad purposes, the second story to offices of the Terminal Company and

entrance, will be a women's room, 22 by 34½ feet, with a lavatory 40 by 40 feet. On the main floor will be a restaurant, 68 by 73 feet, a portion of this space being devoted to a lunch counter. A private dining-room will be on the second story. The kitchen and bakery will be on the second floor. There will also be a barber shop, 34 by 42½ feet, provided with bathrooms on a gallery, and bootblack-room in close connection; a stationmaster's room; smoking-room, 37 by 60 feet, and men's lavatories, carriage offices, telegraph and telephone offices, bureau of information, newspaper stands, etc., are provided.

The train shed will be in three spans, and a roof of one sweep, which, together with the roofs over the baggage-rooms and midway, will make a roof of over 700 feet long and 650 feet wide, this being the largest railway building roof in the world, nearly 10 acres. Just as we go to press word comes that the contract for the steel work of this train shed has been given to the Pennsylvania Steel Company. The contract is for about 7,000 tons of steel, and the price is said to be between $300,000 and $400,000.

The station as a whole, when completed, will have a capacity far in excess of any other in existence, and will be the first one in which elaborate provision has been made for a motive power other than steam. As to what power shall be used for the suburban traffic, nothing can be said positively, but the company knows from its own experience that electricity is a success, and it also hopes to have a successful compressed air system presented to it before the time for deciding upon the motive power arrives.

The officers of the Boston Terminal Co. are: Chairman of the Board of Trustees, Charles P. Clark (President N. Y., N. H. & H. R. R.); Vice-Chairman, Samuel Hoar (General Counsel, B. & A. R. R.); Trustees, Chas. L. Lovering, Francis L. Higginson and Royal C. Taft; Manager, John C. Sanborn; Resident Engineer, George B. Francis, M. Am. Soc. C. E.; Treasurer, Charles F. Conn; Clerk, W. Perkins. The engineering features of the plan were developed by Mr. Francis, in consultation with the chief engineers of the roads which will enter the terminal, and under the supervision of the board of trustees and the manager of the Terminal Company. The architects of the station building are Shepley, Rutan & Coolidge, of Boston.

We are indebted to Mr. Francis for the plans and the information for which we have prepared this article.

Water-Tube Boilers—Liquid Fuel.

In the *Year Book* of the Office of Naval Intelligence, just issued, considerable space is given to water tube boilers. After a description of Mr. Yarrow's experiments made in January, 1896, the report goes on to say that great differences of opinion are still held by authorities on the relative merits of Scotch and water-tube boilers, and on the efficiency of the various types of the latter. Mr. Durston, Engineer-in-Chief of the British navy, says:

"The general question of the use of higher steam pressures, which necessarily involve, in my opinion, the use of water-tube boilers, will be of interest, . . . and if it be shown by experience that increased pressures can be obtained with water-tube boilers with safety and efficiency, and that a considerable gain in economy results from the use of such high pressures, no doubt the mercantile marine will be forced by competition to their adoption, assuming, of course, that any practical difficulties are shown by experience to be overcome when proper appliances are fitted. One very important reason for the adoption of very high pressures exists in the navy, however, to a much larger extent than in the mercantile marine, and follows from the fact that with naval machinery the usual power exerted in service is but a small proportion of the full power. It is well known that such small powers cannot be developed in a large engine with economy, and one advantage of the provision of very high pressures for the maximum power lies in the reduced size of engine which results, and which will have a beneficial effect in making the engine more economical at those low cruising powers which the vessel exerts during most of her life.

Besides this special advantage which accrues in the navy, there is, of course, the general advantage of lightness. There are certain types of war vessels where the development of the highest possible power for short spurts is of paramount importance, and this highest possible power is required on the lowest possible weight of machinery."

A series of experiments has been carried on at Devonport to determine the distribution of temperature over the tubes and tube plates of boilers, and the results showed that tubes remained tight up to a temperature of 750 degrees Fahrenheit, but above this leakage must be expected; that the loss of efficiency due even to a slight deposit of grease in the boiler was about 11 per cent., and that brass and copper tubes were more liable to leakage than steel and iron tubes. In consequence the brass and copper tubes, where used, are being replaced by steel tubes in the British service.

The *Year Book* says that the adoption of the Belleville water tube boiler for certain of the larger vessels of the British navy has met with disapproval on the part of many engineers who consider that this boiler has not yet proved its superiority to the Scotch boiler as a steam generator for large vessels. Trials are quoted as showing the wastefulness of the Belleville boiler and serve as an argument against their use. The two vital objections urged against water tube boilers by their opponents, and which the Admiralty is claimed to have overlooked, are. (1) The greater coal consumption per indicated horse power per hour as compared with cylindrical boilers; (2) the greater number of firemen and coal-passers required for a given power. The case is cited in which Belleville boilers were fitted in the new steamer *Ohio*, plying between Hull and New York. There were four of these boilers of 2,000 indicated horse-power, 6,000 square feet of heating surface, and 192 square feet of grate area. The tubes gave great trouble from leakage, and the lack of economy has caused the company to order cylindrical boilers for a new steamer now under construction.

The adoption of Bellville boilers by the British Admiralty was severely criticised in Parliament in June, when it was charged that they were adopted without sufficient trial, and that if they proved a failure 23 vessels of the navy would have to be supplied with new boilers. The Admiralty, however, held that the strategic value of the boiler, in gettting up steam rapidly, outweighs all disadvantages. The advantages claimed for the Belleville boilers by the Admiralty in defense of their action are the ability to raise steam quickly from cold water; the rapidity with which fires can be withdrawn, the grates cleaned, the tubes swept and the boiler put under steam pressure again; a control of steam pressure so complete that the engines can be suddenly stopped from full speed without the pressure rising or any injury to the boiler; less liability of fatal consequences if the boilers are injured in action; and finally, that the water-tube boiler can be removed from a ship with less damage to the latter than in the case of a cylindrical boiler.

Time and experience will develop the practical value of the water-tube boiler for large war vessels. Their value in torpedo vessels, where great powers and speeds are required for short periods, is now generally conceded. France has used the water-tube boiler in her larger vessels for some years and does not discard them for inefficiency, and other powers are extending their use of them. The largest installations in the British Navy are those in the sister cruisers *Terrible* and *Powerful*. In the *Terrible* there are 48 boilers, located in eight boiler rooms, and arranged symmetrically on each side of a central longitudinal bulkhead. The boilers stand transversely in the ship. The total grate area is 2,200 square feet, and the heating surface 67,800 square feet, the ratio between the two being 1:30.8. The horse-power is 25,000. The steam pressure is 260 pounds, reduced to 210 pounds at the engine.

On the subjects of water-tube boilers and liquid fuel, Commodore Melville in his recent annual reports says:

"The water-tube boiler question is one that is absorbing the attention of all designers of naval machinery, and the aim in all cases seems to be to get a boiler which, while being reasonably light, shall be capable of ready repair in case of a ruptured tube, and contain so much water that a slight derangement of the feed apparatus will not result in burning out the boiler. The Bureau during the past year made tests of two different types of these boilers, both being in steamers on the lakes, the owners of which kindly placed them at the disposal of the Bureau for such tests and examination as could be made without interfering with the service on which they were engaged. The first steamer experimented with, the *Northwest*, belonged to the Northern Steamship Company, and plying between Buffalo and Duluth, was fitted with Belleville boilers; the second one, the *Zenith City*, engaged in freight service between the same ports, with Babcock and Wilcox boilers.

"For the purpose of comparing the results in the latter case with what might be expected from the ordinary cylindrical boilers under like conditions of service, a similar test was made on the steamer *Victory*, belonging to the same company as the *Zenith City*, and practically identical with her in all respects save boilers. As a result of the three tests above mentioned, and a further evaporative test of a Babcock & Wilcox boiler by the Bureau, it was decided to fit this type of boiler in the *Chicago* for about 4,500 indicated horse-power—one-half her power. Subsequently to the award of contract, the Department, upon the recommendation of the Bureau, approved the request of the contractors for the construction of gunboat No. 10 and for gunboat No. 15, to supply this type of boiler instead of the cylindrical one of the original design; and the fitting of this boiler in those two classes of gunboats will give an excellent opportunity to demonstrate its value as compared with the cylindrical boilers fitted in the other gunboats of the same class.

"The experiments conducted at the New York Navy Yard in using liquid fuel in the third-class torpedo-boat of the *Maine* have been completed. The evaporative results were good, even at the highest rates of combustion, and it only remains to ascertain whether the stowage and carrying of this fuel can be so effected as to eliminate danger from the gas that may be given off, which is the one objection to the use of any fuel oil other than petroleum refuse. It is to be regretted that conditions, other than those per

taining to the system of burning the fuel in these boats, operated to prevent a trial of the boat in free route for any length of time. The Department having authorized the fitting of this system in one of our tugs, in order to demonstrate its practicability under ordinary conditions of service, preparations are being made to use 'fuel oil' only in this boat, and it is hoped that the results will be such as to warrant its general use for tugs and torpedo-boats."

In the use of petroleum, now constantly increasing in favor as a fuel for marine boilers, France takes the lead, using it in mixed combustion with coal. The *Year Book* says that all the new vessels of the French navy will be fitted for burning this auxiliary fuel, and the vessels in commission will also have their boilers converted for this purpose. The petroleum used is refuse oil, of the consistency of thin molasses, of a yellowish color, and comparatively odorless. The liquid fuel is admitted to the furnaces in the form of spray, greatly increasing the intensity of the heat, and in proportion to the amount of petroleum so admitted. The use of forced draft is thereby avoided with the consequent discomfort of the closed fire room; and means are provided of quickly increasing the speed without increasing the labor. The wear and tear on the boilers is less than that produced by forcing the draft. The only waste is that of the fresh water expended in pulverizing the petroleum, for which live steam is required. The various types of pulverizers are shown in an article on liquid fuel by Col. N. Soliani in the "Transactions of the World's Columbian Exposition Engineering Congress," which also gives some results of the use of liquid fuel in Italy. Mr. Jules d'Allest has published another valuable addition to the literature on this important subject.

In the French service the ratio of petroleum to coal burned varies from 0.17 to 0.65, depending on the vessel, type of boiler, thickness of the fire and degree of forcing required. The heating efficiency of petroleum compared to that of coal is as 10 or 12 to 8. The increased expense of the petroleum prevents its sole use as a fuel, the Russian article delivered in France costing at least price the cost of coal, not taking into account the duties imposed.

A liquid fuel installation consists of: (1) A storage tank holding about six tons, placed high in the bunkers to aid the flow of the oil; (2) a pump on the floor of the fire room, which pumps the oil from the tank to a reservoir; (3) a reservoir, consisting of a metal cylinder holding 35 gallons, where the oil is under a slight pressure; (4) a burner for each furnace, with piping from reservoir; (5) piping to conduct live steam to the burners to pulvarize the petroleum. The force and fineness of the spray is controlled by valves in the burner, and a shower of pulverized oil is distributed over the surface of the fires.

It has been shown that by using the petroleum the speed may be increased from eight to thirteen knots in from seven to fifteen minutes, without increasing the expenditure of coal. The larger vessels will carry from 60 to 80 tons of the liquid fuel. It is urged by some that torpedo boats use liquid fuel only, on the ground that for these small vessels it may be made as cheap as coal, after carefully developing the system of combustion to the highest possible state of efficiency. A type of boiler for the sole use of petroleum has been designed by Mr. Seigle, and is under consideration by the French Navy Department. Great results are claimed for this boiler, the principal characteristics of which are: (1) Complete and direct utilization of the heat produced and rapid circulation of the water; (2) division of the single furnace into a number of tubular telescopic furnaces so as to increase the heating surface and consume the fuel regularly; (3) perfect combustion, the gasses issuing from the smoke pipe being without trace of carbon monoxide.

Germany is beginning to use liquid fuel more extensively and Italy is installing it in all torpedo boats. It is stated on later authority than the *Year Book* that the German naval authorities have decided to equip all the existing large men-of-war in the German navy with apparatus for burning oil with coal under the boilers, and the use of liquid fuel will, it is stated, be provided for in all new vessels. The oil will be stored on board in special tanks, from which it will be pumped to the furnace and ejected in a spray by steam. For the storage on shore of the liquid fuel in large quantities, reservoirs holding over 100,000 gallons have been built at Wilhelmshaven, and similar tanks are to be put up at Kiel and Dantzic.

The trials of the new British cruiser *Terrible*, a sister ship to the famous *Powerful*, were as satisfactory as those of the latter vessel. On the first trial, with about 18,000 horse-power and with 102 revolutions of the starboard engines and 100 of the port, the mean indicated horse-power was 18,493 for the 30 hours, and the speed of the vessel, as taken during three hours' run on the measured distance, was slightly under 21 knots. With 112 revolutions per minute starboard and 111 port, and a total horse-power of 25,572, a speed of 22.41 knots was obtained.

The Uses and Limitations of Compressed Air.

At the December meeting of the Western Railway Club there was a most instructive discussion on the paper on compressed air read by Mr. McConnell at the preceding meeting. We give below an abstract of the discussion:

Mr. Geo. Gibbs (C., M. & St. P. Ry.): I think that Mr. McConnell has cited some very sensible applications of compressed air for shop use, and I entirely agree with him until in the latter part of his paper he mentions some uses to which I think compressed air is not well adapted. He mentions having a three-cylinder Brotherhood engine operated by air, which he uses for running an 18-inch slotter, a 42 by 42-inch planer, and for wheel lathes; and, further, he speaks of the use of an air engine for running a transfer table of 100 feet travel. I believe in these instances he is going entirely out of the legitimate field for use of compressed air. He also speaks of doing away with line shafting entirely. "No main line shafting extending the entire length of the shop is necessary. A short line shaft may be used for heavy machinery and all the light machinery may be driven by air." There he is treading entirely upon the province of the electric motor, in my opinion. I am not able to present now a thoroughly digested statement of just what the two fields are; but, immediately before the meeting, I jotted down some general headings of groups under which I think the two agents might severally be used to advantage. In railroad shops compressed air is adapted—First: For short hoists or direct lifting operations, such as jacks, and air hoists for unloading car wheels and for placing heavy weights on lathes and planers. Second: It may be used for pressure tools, or light work like stamping and pumping. Third: It may be used for working a tool for striking short, quick, light blows, such as riveting and caulking tools for boilers. Fourth: It is adapted to air-blast purposes, such as mixing paints and whitewashing. As a fifth use might be mentioned its employment for transferring oils from cars to tanks in oil-houses. When these five headings are considered I think we have about got to the end of the catalogue of cases in which air can be used to special advantage, although, of course, there are many other places where it can be used, but not as economically as could some other agency. The uses to which I consider electricity adapted for are:

First, for lifting purposes, such as in traveling cranes. Second, for conveying operations, such as in transfer tables and traveling cranes. Third, for rotary power tools, which would comprehend the general group of individual motors for running large machine tools; also small special motors adapted for drilling and tapping. This drilling and staybolt tapping has been done by air tools, but I think it can be done much more satisfactorily by motors, although I confess that I have not seen any motor which has been put on the market which completely fulfills the conditions of the requisite lightness and reliability. The urgent demand for this class of electric tools will, however, doubtless result in their being forthcoming in the near future.

Mr. C. H. Quereau (B. & M. R. R.): Admitting all the economy to be obtained by the use of compressed air in the shops, there is such a thing as carrying it too far, and in saying this I do not wish to be understood as adversely criticising Mr. McConnell's paper. To illustrate: One of my friends recently said that he had some revelations as to the value of labor-saving devices when he came to put his men upon piece work in repairing locomotives. Most roundhouses are fitted with stack lifts for taking the steam-chest covers off and lifting the valve out. When this operation was put on piece work, a couple of men would take a stick and lift that steam chest off while they could adjust the stack lift. It is apparent that compressed air is not always economical, though it may be a convenience. I think it is a subject that will bear considerable investigation and considerable discussion before arriving at a final conclusion for any given use, and I think the system of piece work will give us data and some enlightenment on that point.

Mr. J. F. Deems (C., B. & Q. R. R.): Mr. Connel's paper brought to my mind an experience which I had a year or two ago and some impressions or convictions growing out of that experience, all of which was very much in line with the last speaker's remarks.

We introduced piece work into one of our roundhouses and locomotive repair shops and you can imagine my surprise when I found some of the tools, which we had looked upon as the very best, cast into the corner and not used at all, one of them being the small crane for lifting steam chests to and from their places on the engine, such as Mr. Quereau speaks of as having seen in another place where it suffered the same fate on the introduction of the piece-work system. The same was true of some of the other devices, which, as the piece work was extended more and more, fell into disuse, showing conclusively that while they might be marvels of mechanical skill and might afford their designers much satisfaction on display occasions, they were not in the proper sense of the word labor savers and hence not revenue producers. This was by no means true of all such appliancers, in fact, the introduction of piece work resulted in bringing out some new ones. But I venture to say that to-day there are many lathes or other machine tools supplied with air hoists where time is continually wasted in getting such hoists into position and making hitches to raise work into the machines which could be lifted into place with one hand in half the time it takes to make the hitch. The same is true of apparatus that I have seen used in car repair yards for lifting drawbars into position. It would take more time to get the machine to the point where it was to be used and get the drawbar into position on the machine than it would to get it into place on the car with the old-fashioned "armstrong" method.

I believe that if the same amount of time and energy had been expended during the past four or five years in introducing and perfecting this or some other better method of handling men, that has been spent in getting up novel machinery for the men to use in handling the work, the results would have been much more satis-

factory from a financial standpoint. If there was the same spirit of rivalry between shop foremen to display their business ability in handling their shops that there is to display their mechanical skill in getting up these complicated devices, the result, in my opinion, would be a net gain.

Mr. B. W. Thurtell (Consulting Engineer): The lack of economy in the use of compressed air is due to the prevailing method of compressing. Old direct-acting pumps are often used without expansion, and these use from 110 to 150 pounds of water per horse power per hour; whereas, if a modern compressor with a modern type of Corliss engine were used, only 30 pounds of water per horse-power per hour would be required and we would get satisfactory economy. Mr. Kolbe, Chief Engineer of the St. Louis Bridge and Terminal Association, whose plant is located in East St. Louis, has two air compressors. The compressors were small, yet they were able to do the work running at a speed of 80 revolutions per minute; soon, however, more work being added, the speed was increased until they were running up to 250 revolutions per minute. Steel air valves were used and the duty was so great that new valves were required every other day owing to the excessive wear. At that plant the compressed air is used for the switch and signal system, also for a slide valve engine to run a machine shop about three-quarters of a mile from the power plant, and this is done without loss in pressure in the receiver. An air pipe is laid across the Eads Bridge to St. Louis, where power is rented which nets an income of 20 per cent. of the cost of operating the compressed-air plant.

Mr. T. Symington (Richmond Locomotive Works): Mr. McConnell estimates that he saves $10,000 a year by the use of his various appliances. We have spent a great deal of money in Richmond on air machinery, and we believe that pneumatic transmission has come to stay. While the field is to some extent limited, yet the uses of compressed air are certainly not few. We use it very successfully with hoists, and we find that in our boiler shops where we could build only three boilers a week without the air for tapping the staybolts and screwing in the staybolts, we can now build four boilers a week by the use of a very few of these air machines. We have also used air for blowing out cylinders and cleaning the castings, and find it very efficient.

There is one thing about the air machine that we have about decided, and that is that any machine with a rotary piston will not last properly. We have tried every one that is in the market and have not found one that will not be more trouble than it is worth. Mr. McConnell told me that he had gotten up a three cylinder air machine weighing 28 pounds, which will develop five horse-power with compressed air. Twenty-eight to thirty pounds is about as much weight as a man can handle in tapping out staybolts and screwing in the bolts, so we are now thinking of getting up a three cylinder piston machine for doing this work and we believe that wherever air is used with a reciprocating piston that it can be used economically. Mr. McConnell further told me that he found that with one of his reciprocating piston machines he could develop power enough to drive a staybolt tap with the exhaust from the rotary machines. It has been confirmed by experience that the rotary is very wasteful.

Mr. J. E. Sague (Schenectady Locomotive Works): We have been using compressed air quite extensively, and in a general way like that spoken of by Mr. Symington. We use it largely for hoists and for that work find it very economical. As almost all our work is paid for on the piece-work plan, we do not find the men using the air hoists to handle parts which can be easily lifted by hand, and no hoists are put up at machines for which the work to be handled is light. We find for much of our work, in which the choice can be made between a rotary air machine and the electric motor, that the electric motor promises better than the rotary, because it gives more power, and does not cost so much to run. The electric motor has one disadvantage, however, which is the increased weight and space occupied.

Mr. E. M. Herr (C. & N. W. Ry.): I shall have to take exception to the last paragraph but one in the paper, in which it is stated that a short line shaft may be used for heavy machinery and all the light machinery may be driven by air. This looks, I take it, to the installation of air motors in machine shops, as many electric motors are being installed in various places throughout the country, and with, as I understand, very good success in economy. I am inclined to doubt very seriously whether the air motor is adapted for this service. I say this because it seems to me that the experience thus far had with air motors shows that they are not nearly as efficient, and I doubt very much whether the outlook ahead would indicate that they can be made nearly as efficient as electric motors as a means of transferring energy from central stations to detached motors.

In France compressed air has been used as a means of transmitting power probably to a greater extent than in any other country. In looking up the matter of experience with the use of compressed air in motors in that country I found some data which throw a little light upon what it costs to run motors which had been developed to a pretty high state of efficiency. In small rotary engines, in Paris, it was found by careful tests (I quote from Kent's Handbook) that as high as 2,330 cubic feet of air per brake horse-power per hour were used. I do not doubt that many machines used to-day in machine shops for the purpose of tapping and drilling holes will show fully as large a consumption of air per horse-power developed in the small motors. In very small motors used for running sewing machines, developing about one-tenth horse-power, the best performance is 1,377 cubic feet of free air per horse-power hour at 384 revolutions. The best performance in a five horse-power rotary engine with air reheated to 356 degrees Fahrenheit, running at 350 revolutions, is 791 cubic feet per horse-power hour. The ordinary practice with high class, well-designed motors shows a consumption of about 1,200 cubic feet free air per horse-power per hour when furnished at 50 to 60 pounds per square inch in pressure. From tests recently made on a high class compressor, with Corliss valve gear and compound air cylinders, with an inter-cooling attachment between the cylinders, I am led to believe that with steam at 80 pounds pressure and the machine running at 75 revolutions per minute it is about all that ought to be expected to get that air for an expenditure of 30 pounds of water per horse power per hour; that is, per horse-power per hour developed in the steam cylinder when we use the air in motors that will give as good an efficiency as 1,200 cubic feet per horse-power per hour.

The efficiency of the transmission from the steam engine to the motor will be about 25 per cent. as it required one horse-power to produce 300 cubic feet of compressed air per hour. This efficiency is of course obtained without heating the air. If air is reheated it is possible perhaps to raise that efficiency as high as 40 per cent. and possibly a little higher than that.

I am very greatly in favor of using compressed air in repair shops; I think it is productive of economy, but it is productive of economy when it is compared with hand labor, and not generally when it is compared with the most efficient means of transmitting energy. I do not believe that it can compare with efficient transmission of electrical energy for use in running line shafting and operating detached machine tools and uses of that kind.

Mr. William Forsyth (C., B. & Q. R. R.): Our compressor consists of a 10 by 48-inch air cylinder attached tandem to one of the cylinders of the shop engine, an 18 by 48-inch double Corliss engine. It is jacketed and cost $300. We have indicated the engine with the air compressor free and also when it was compressing air to 80 pounds and found that it required 40 horse-power. We get a horse-power with the Corliss engine with 4¼ pounds of coal per hour, and the air compressor consumes 204 pounds of coal per hour, and at $3 a ton the cost of 1,000 cubic feet of free air compressed to 80 pounds is 10 cents. With coal at $1.50 per ton it is, of course, only 5 cents per 1,000 cubic feet.

Referring to the paper under discussion, I would also take exception to one of the suggestions in the latter part of the paper relating to the use of compressed air for furnace blast and for forge fires. That is probably the most expensive application of compressed air that I have heard of and it at least costs ten times as much to produce blasts in that way as it would with a fan, and this brings us to the wastefulness of the application of compressed air. I believe that this is the next thing that we must go after and that there is a larger field perhaps in effecting economy in getting efficient tools to use for the application of compressed air than there is in perfecting any further the air compressor. This will be readily appreciated when we remember that if we have an air leak from an 80 pound pressure through a hole one-quarter inch in diameter it will use up more than a 10 horse-power compressor can deliver. Now in going through the shop the other day I noticed that one of the apprentice boys had a hose connected to the air pipe and he was blowing the chips out of the hole he was drilling in cast-iron, and the power used in getting those chips out was a great deal more than would be required to drive the drill press and boy too. And that is only an illustration of the tendency to waste all through the shop. You will find in the summer time that the men have pipes of that kind where they are cooling themselves with an air blast, and the small holes all about the shops, leakages in the pipes, will use up a great many horse-power of compressed air.

Mr. William A. Parker (Ingersoll-Sergeant Drill Company): Compressed air is, as we all know, a power which has only recently been investigated and installed by the railroads. The process of producing compressed air commenced in a very primitive way by the use of the Westinghouse air brake pump, which should have the honor of the introduction of compressed air to railroad uses and shops. From that day we have gone on in the improvement and manufacture of compressors, until we can confidently say that with a four stage compressor, with the Corliss valve gear, compound condensing type, we can produce 1,000 cubic feet of free air compressed to 1,000 pounds for less than 2½ cents. This is by actual test. There are tests going on to-day in the city of New York with a four-stage compressor which will in a short time be completed, and then we shall have authentic figures for compressing air to 1,000 pounds and over per square inch.

Speaking of the losses in compressed air there is no excuse for a leak in the mains, or through the shops. Where the mains are properly laid and taken care of in the first installation, I have never heard of a leak that has occurred afterward, except as a result of an injury.

The use of compressed air is, I think, in its infancy, and it has only recently claimed the attention of scientific men and mechanical engineers. I think it will from this on progress; as has electricity. I do not think it will take the place of electricity, but as a motive power I think it will fill a long needed want. Compressed air in street car service has not yet been sufficiently advanced, nor have experiments been made to advance any accurate figures or facts, but compressors and compressed air for railroad use and for railroad shops are attracting the most attention to-day. I think we can safely say that with compressors of the straight line type, with the common Meyer valve with adjustable cut-off, that we can produce compressed air, with coal at about $3 per ton or less, for less than four cents for 1,000 cubic feet of free air compressed to 100 pounds. This includes all expenses of operation and interest on investment.

Mr. J. F. Lewis (Rand Drill Company.): There is a great increase of efficiency in reheating the air before it enters the working cylinder. Of course it costs something to do this, but the cost is very small compared with the increased efficiency. This has been demonstrated in using compressed air for street car propulsion. During an experiment, the cars were run about 40,000 miles. The air was carried in storage tanks, at from 600 to 800 pounds pressure, being passed through water heated to 360 degrees to a reducing valve and direct to the working cylinders, where it was used at from 50 to 150 pounds pressure according to the grades or the condition of the track. It was found that the cars could be run 8 to 10 miles when the air was reheated, and only four to five with cold air. This was known as the Mekarski system, which has been used successfully in Nantes for the last eight or nine years, and three years ago three street car lines were established in Paris under the same system

They carry the air at a pressure of between 1,100 and 1,200 pounds, reducing it to the proper pressure when used. We have also made experiments in our shops, which convinced us that it produced much better results by being used hot. In Paris, where air is carried about the city for power purposes by the means known as the Popp system, an efficiency of 92 per cent. is claimed with heated air, as against 70 to 72 per cent. not heated, and it is believed to pay well to reheat.

I have a letter from Mr. George W. Smith, Master Mechanic of the A., T. & S. F. Railway, Topeka, Kan., in which is given data in regard to the cost of compressing air used in the shops at that point, which gives the following:

A., T. & S. F. R. R. COMPRESSOR.

Steam pressure, 80 pounds.
Air pressure, 100 pounds.
Tons of coal of 2,000 pounds per month, 155.
Cost of coal per month, $139.50.
Cost of coal per ton, 90 cents.
Amount of free air per minute, 1,712 cubic feet.
Amount of free air per day of 10 hours, 1,027,584 cubic feet.
Amount of free air per month of 31 days, 31,855,104 cubic feet.
Revolutions per minute, 50.
Pounds of coal per 1,000 feet of free air, 9.7.
Cost per 1,000 feet of free air, .00437 cent.

This compressor is fitted with Meyer adjustable steam valves, compound-air cylinders with mechanical-air valves on the low-pressure cylinders. Air is taken from outside the engine room; The above cost is for fuel only; for the air delivered from the compressor, that is the cost of oil, labor and interest on cost of plant, is not considered. The steam cylinders are 20 inches by 48 inches, air cylinders, 28 inches and 16 inches by 48 inches; horse power, 310.

I will say in connection with this, that there are five miles or over of piping through these shops and yards, in which compressed air is carried to the different tools. As to the saving over the old way, Mr. Smith says:

"With the 10-foot reach, stationary riveting machine we can drive 2,000 rivets per day of ten hours, with three laborers at a total cost of $4.75 per day. This compared with hand labor three men, total $7 per day, will drive 200 rivets. The 6-foot riveter, the combination flange punch and riveting machine and the bridge and girder riveter will each average about the same as the 10-foot reach riveter. The truck riveters; one machine operated by two laborers at a total cost of $3 per day, drive 3,000 rivets in a day of 10 hours, as compared with hand labor, three men at a total of $6 in the same class of work who will only drive 175 rivets. The frame riveter will average about the same as the truck riveter. The staybolt breaker will make an average saving of $8 a day. The tank riveter will make an average saving of $10 a day. The mud ring riveter will drive as many rivets as can be handed to it, and will make a saving of from $12 to $15 a day for that class of work. Not only does it make a great saving, but it insures every rivet hole being entirely filled and insures tight work, while a large per cent. of hand driven rivets in mud rings invariably leak and have to be caulked or fullered. The staybolt cutter will do the work of 15 men; this looks rather fishy, but it is a fact. You have seen this machine work, and it will very easily cut off 1,500 bolts an hour, while when cutting them off by the old method of hand hammer and chisel you must agree that progress is very slow and that it is hard work. The rotary tapping and drilling machine will do the work of six men. The rotary grinder saves the work of six men. The rotary saw for sawing car roofs saves the work of four men. The pneumatic hammer will save the work of three men. A rail saw saves the work of two men. A rail drill saves two men. The device for operating transfer table saves $6 per day. The machine for revolving driving wheels for setting valves saves the labor of two men. The device for shearing bolts saves the labor of three men. Thirty hoists in various parts of shops save the labor of 10 men at $1.50 per day. Apparatus for loading and unloading oil at the storehouse saves $6 per day over the old method. A jack for pulling down car draft sills saves $10 per day. A device for fitting up hose couplings over the old methods saves $15 per day. With the pneumatic painting machine, one man does the work of 10 using hand brushes. The machine for tearing down old car roofs saves $8 per day. A jack for raising and lowering freight and passenger cars makes an average saving of three men. The drop pit makes an average saving of two men. The device for sending engines saves one man. The shifter for switching cars in shop yard saves $50 per week. The coal-cleaning device saves ten men. The flue roller makes a saving of two men over the old method. The white-washing machine will do the work of ten men with brushes."

Mr. J. N. Barr (C., M. & St. P. Ry.): There is no doubt that with the improvement in compression we can get compressed air at very reasonable figures, but what I feel a little doubtful about is the multiplicity of uses to which it is being put and the apparent saving in men. It is true that you can do all these things just as they are shown, but there is a likelihood of extra men being about the work getting it ready and watching it through. There are many cases where it is an absolute impossibility to spare the men that are necessary for initiating some of these operations and unless this matter is watched with an eagle eye, I think that these leaks are going to be a great deal worse than the leaks out in the air pipe and with scattered work such as we have in railroad shops I am perfectly frank to say that I am more afraid of those leaks than I am of the losses of the use of air, and more afraid of losses there than in heating of the air due to compression and the consequent loss. There are cases in which compressed air can be used to good advantage and good results that are unquestioned may be obtained; there are other cases wherein it can be used, but used at a very great disadvantage and in these cases as some of our members have said, it has been found cheaper to throw the devices away entirely.

When compressed air begins to compete with electricity as a rotary agent, I feel inclined to think that it is tackling a problem in which it is coming out second best. We have all heard to-day about the difficulty in the way of making rotary engines. I heard of it when I was a boy. Now, on the contrary, with electricity you cannot get a satisfactory motor except a rotary one. It utilizes the power in the very best and most advantageous way and I think it has its field in that respect and it looks to me now that for rotary motion and continuous work compressed air is going to have a very hard time maintaining itself beside electricity. The development of both at the present time is comparatively new and that opinion may, when you look at it a few years hence, sound like arrant nonsense. However, it remains to be seen.

New Passenger Locomotives for the New York Central and Hudson River Railroad.

The Schenectady Locomotive Works have recently built a lot of eight-wheeled locomotives for the New York Central & Hudson River Railroad Company, from specifications and drawings prepared by Mr. Wm. Buchanan, Superintendent of Motive Power. The boilers of the new engines have a very large heating and grate surface—a very important feature in fast heavy traffic, and one which Mr. Buchanan has always advocated. The driving and truck journals are of very large size, while the driving boxes are of solid Magnus metal. The driving wheels are cast of gun iron. The piston rods are extended through front cylinder heads—a practice which has been found very advantageous by Mr. Buchanan—reducing to a minimum the trouble with wear of cylinders and broken piston rods.

All these engines are in fast service on the celebrated "Empire State Express," the Fast Mail, and the Chicago, St. Louis & Cincinnati Limited trains, and have already made some exceptionally fast time on these trains.

On Dec. 1, one of the engines, No. 924, made the run with train No. 50—the "Empire State Express," east—from Syracuse to Albany, a distance of 147.84 miles, in two hours and thirty minutes, including a three-minute stop at Utica, together with a slow-down going through Schenectady and a slow-down going the streets of Syracuse, a distance of about one and one-half miles, in compliance with that city's ordinance limiting the speed to eight miles per hour. Deducting ten minutes for the time in running the one and one-half miles in Syracuse and three minutes' stop at Utica, leaves the running time from the city limit of Syracuse to Albany, two hours and seventeen minutes. Deducting the one and one-half miles in Syracuse from the total distance leaves 146.34 miles, which made a speed of 64 miles per hour for the 146.34 miles, not allowing for slow-down through Schenectady.

There were ten engines in the above lot, five of which had drivers 78 inches, while the other five have drivers 70 inches diameter. From the specifications we take the following:

GENERAL DIMENSIONS.

Weight in working order	136,000 pounds
" on drivers	90,000 pounds
Wheel base, driving	8 feet 6 inches
" " total	23 feet 11 inches
Cylinders	19 by 24 inches
Piston rod packing	U. S. metallic
Kind of slide valves	Richardson balanced
Kind of valve stem packing	U. S. metallic
Diameter of driving wheels outside of tire	78 inches
Tires	(Midvale steel) held by shrinkage and retaining rings
Driving box material	Magnus metal
Diameter and length of driving journals	9 inches diameter by 12½ inches
Diameter of engine truck wheels	36 inches
Kind " " " "	Krupp No 3
Style of boiler	Wagon top
Outside diameter of first ring	(Smoke-box jacketed) 60 inches
Working pressure	190 pounds
Mat'l of barrel and outside of firebox	Carbon steel
Firebox	108⅛ inches by 40⅞ inches
Firebox material	Carbon steel
" staybolts	Brown & Co.'s U. S. iron, ⅞ inch and 1 inch diameter
Tubes, material	Syracuse S. L. W. charcoal iron, No. 11 W. G.
" number and size of	288, 2 inches, O. D. by 12 feet 1⅛ inches long
Heating surface, tubes	1,809.56 square feet
" " water tubes	12.93 square feet
" " firebox	158.23 square feet
" " total	1,980.72 square feet
Grate "	30 69 square feet
Boiler supplied by	Two Monitor injectors, No. 10 R. S., No. 9 L. S.
Tender frame	6½ inches by 4 inches by ¾ inch angle iron
Water capacity of tank	4,500 United States gallons
Coal capacity	8½ tons

The engine is equipped with a double-riveted mud ring, two 3-inch Consolidated muffled safety valves, Westinghouse automatic air-brake on drivers, tender and for train, Westinghouse air signal, 9½-inch air pump, asbestos cement boiler lagging, Gould pilot and long shank tender coupler, water scoop on tender, piston rods extended through front cylinder heads, Nathan No. 9 triple-sight feed lubricator, springs made by Schenectady Locomotive Works, star round case headlight, American steel brakebeams on tender, and Ross-Meehan shoes.

(Established 1832.)

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

28TH YEAR. 66TH YEAR.

PUBLISHED MONTHLY BY

R. M. VAN ARSDALE,

MORSE BUILDING..NEW YORK

M. N. FORNEY, W. H. MARSHALL, } Editors.

R. G. CHASE, 705 Western Union Building, Chicago.

FEBRUARY, 1897.

Subscription.—*$2.00 a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union.*

EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Special Notice.—*As the* AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL *is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 25th day of each month.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* **When a subscriber changes his address** *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

The paper may be obtained and subscriptions for it sent to the following agencies: **Chicago,** *Post Office News Co., 217 Dearborn Street.* **London, Eng.,** *Sampson Low, Marston & Co., Limited St. Dunstan's House, Fetter Lane, E. C.*

There are few men who in the conduct of their business are so matter of fact and so far removed from the charge of being sensational as is Mr. G. W. Rhodes. But whether he inteuded it or not he created somewhat of a sensation when he announced as the subject of his paper before the Western Railway Club "Has the Air-brake a New Enemy?" Curiosity, which was greatly aroused, has now been satisfied by the appearance of the paper, and it exposes the enemy in the form of a wasp, whose habitat is the plains of Nebraska, that has developed a fondness for railroad travel. It enters the shell of the retaining valve and there perfects certain incubating arrangements that interfere somewhat with the operation of the valve. The proposed remedy is to make the opening in the case a narrow slit, instead of a round hole as at present, thus compelling this intelligent insect to seek a new resting-place when traveling on freight trains.

A hasty reading of the discussion on compressed air by members of the Western Railway Club, an abstract of which we publish on another page, may lead some to think that the general trend of the remarks was against the use of this valued agent. A more careful reading will show that the speakers were not opposed to it, but that they realized the limitations of compressed air, and were disposed to believe that the application of it had been overdone in some cases. Those who hold this view are in reality the best friends of compressed air. With so many possible uses in which economy will result, it would be a pity to bring compressed air into disrepute through unwise applications of it. At the same time it must not be forgotten that with a compressed air plant once installed there are services to which one is justified in applying it, even if its economy would be somewhat less than that of an electric motor, because of the smaller investment necessary or the convenience in the generation of power, or the fact that an electric power plant is not already in operation daily. But compressed air has its limitations, and they should be recognized.

Notwithstanding the large area of the heating surfaces provided in the modern locomotive, it still remains true that the limit to a powerful locomotive's work is always its boiler power. It would not be improper to state that in considering an increase of boiler power, the augmented heating surfaces are more difficult to provide for than is the enlarged grate area ; we can get the grate area somehow, but to get the heating surfaces without exceeding that other limiting condition, a given weight, seems at times next to impossible. And yet the larger grate area is of little value without a corresponding increase in the heating surface, a statement which seems to be supported by the changes now being made in a famous engine that went into service on a Western road some time ago, and whose ratio between grate and heating surface was about forty to one. In view of the difficulty of getting more than 2,200 square feet of heating surface in even the largest and heaviest of modern passenger locomotives, it is of interest to know that a builder has recently been asked by a well-known superintendent of motive power to lay out a design for a passenger engine in which nothing less than three thousand (3,000) square feet of heating surface will be provided. This is virtually 50 per cent. more heating surface than obtained in the engines of to-day, for those that exceed 2,000 square feet are so few in number that they may be considered as exceptions to the rule. If such an engine is produced it is not exaggeration to say that it will mark an era in locomotive design and construction.

THE COST OF ARMOR PLATE.

Elsewhere in this issue will be found a brief summary of the report of Secretary Herbert on the cost of armor plate. The result of his investigation is a recommendation that the armor plate for the three battleships authorized be contracted for at not more than $400 per ton, and that if three more battleships are authorized their armor should be furnished at not more than $375 per ton; and furthermore, that if the two armor-making concerns in this country will not come to these terms, the government buy a plant or construct one of its own. The actual cost of labor and material, exclusive of nickel, is placed at $196.40, and the price suggested, $400 per ton, is claimed to cover fixed charges and give a profit of 50 per cent. Senator Chandler has also made a report on armor to the Senate Sub-Committee on Naval Affairs, in which he recommends a price of $300 per ton, which, he says, gives the makers 33 per cent. profit. He leaves the question of constructing a government armor plant to Congress, but, like Secretary Herbert, places the cost of such a plant at $1,500,000. The attacks on invested capital in this country are so numerous that many of our readers will probably hear frequent charges of selfishness, exorbitant prices and excessive profits made against the companies who have been instrumental in bringing our armor plate up to its present standard. We have no desire to defend the policy of any company that is seeking more than its due, but whatever course is decided upon for the future in letting contracts for armor, the condirions under which the two plants in this county were established should not be forgotten. The Bethlehem Iron Company established the first one, and it is admitted that it cost at least $4,000,000, while some experts place the cost at nearer $5,000,000. The investment of so much capital in a plant of this kind, with the prospect of its continuous employment depending entirely upon the course of Congress, which might at any time change or modify its policy of naval construction, is no mean undertaking, and in view of the

uncertainty of the market for armor it is but natural that the company should expect to have the cost of the plant returned to it in profits in a comparatively short time. That the first plant cost over $4,000,000, that the next one was built for not more than $3,000,000, and that at present a complete plant can be constructed for $1,500,000, is only another proof of the risk of capital in the first undertaking. Furthermore, the advances in armor construction have nowhere been as great as in the United States, and this country now leads the world in this particular. It is quite certain that if the government had begun armor construction with its own plant it would not, up to date, have saved money, and it is equally certain that it would not now be turning out armor as good as it can buy. If the expensive plants which these armor-making concerns erected some years ago have in reality been nearly paid for out of the profits of the business, a reduction of present prices ought to be expected. But the determination of a future policy ought not to be affected by a mistaken belief that the government has been unjustly dealt with in the past, for it has not been so treated when the output of armor has been of honest quality and as good as the manufacturer was at the time capable of producing.

GOVERNMENT INSPECTION OF STEEL.

The investigation into the qualities of the steel plates furnished for the hulls of the battleships *Kearsarge* and *Kentucky* by the Carnegie works has resulted in a voluminous report from the special board of inquiry to Secretary Herbert. The report has not been made public, but it is learned that the steel is satisfactory when tested lengthwise, but does not meet requirements when tested crosswise. The Secretary has directed that the constructor at Newport News (where the ships are being built) may use such plates as will prove satisfactory in view of their position in the ship, each plate to be accepted or rejected after an individual test. Commodore Hichborn, chief of the Bureau of Construction, in forwarding the report of the special board, says in part:

"An examination of the sheet giving the results of tests submitted by the board shows that as regards tensile strength and elongation the metal complies very well with the specifications, the average tensile strength being in the neighborhood of 65,000 pounds, and but two specimens taken from the same plate falling appreciably below the elongation required of 25 per cent. The variations in tensile strength between the longitudinal and transverse specimens are slight and irregular. The average elongation of the longitudinal specimens is 27.7 per cent. and that of the transverse specimens 26.2 per cent. The failures which occurred were in the cold bending and quenching tests, and it is only under these tests that there appears to be any marked difference in the behavior of the transverse and longitudinal specimens—the transverse specimens, as might be expected, showing greater tendency to brittleness."

The cause of the trouble is considered by the board to be the lesser amount of work expended upon the plates in crosswise rolling than in lengthwise rolling, and the defect was not detected because the specifications do not require bending specimens to be taken crosswise of the plates. Irrespective of how much there is in this explanation, it is well known in many quarters that the inspection of steel for the government has for years been carried on in a disgraceful and incompetent manner. The line officers have had control of this work, and the engineer officers, representing the Construction and Steam Engineering bureaus have been in the minority on the steel board and in the force of inspectors. Much of the inspection work has been assigned to men who were not competent for these duties, with the result that the quality of government materials has depended more upon the honesty and ability of the contractors than upon the safeguards of competent inspection. It is gratifying to learn, therefore, that the present detection of inferior materials promises to lead to reforms in the steel board and the corps of inspectors. The steel board in charge of the inspection of all steel furnished for new naval construction has already been reorganized, so that its control is now in the hands of the Construction and Engineering Departments, instead of line officers. Furthermore, it has been announced that the work of inspection will be taken from young line officers who have been stationed at the mills and civilian inspectors employed for that purpose. That is gratifying news, and if it is in truth the opening wedge of reform by which line officers will be made to keep to their legitimate duties, and give engineer officers the opportunity to handle untrammeled the business of their departments, the immediate cost to the government from the delay and the re-inspection of the plates for these ships will be money well spent. In January, 1896, the steel board consisted of two line officers and one engineer officer, and the inspection of steel and armor was performed by six line officers, two engineers, one carpenter and two sailmakers.* So that out of a total of 20 officials concerned in the inspection of steel, there were three engineers, or the same representation as is given the carpenters and sailmakers. During the year the criticisms to which the line officers were subjected compelled them to alter the personnel of the inspectors somewhat, but they still kept their grasp on the steel inspection. Now it seems that this exposure of their methods has compelled them to turn over the inspection to the officers to whom it rightly belongs. It is said that the new board will at once take up the work of revising the specifications for steel.

AMERICAN MACHINE TOOLS ABROAD.

An exhibit of admirable cycle-making tools by the Pratt & Whitney Company, of Hartford, at a recent cycle show in England, is the occasion of an editorial in *Engineering*, in which the superiority of American tools of this kind are plainly set forth. After stating that the special tools in use by cycle manufacturers in England have in the main been devised in their own shops and are not to be bought in the market, our contemporary says:

"The American makers have stepped in and are at the present time reaping a rich harvest in selling, pretty well at their own prices, special cycle-making machinery of a nature which cannot be purchased from British manufacturers. The fact is the more annoying because there is nothing in these tools which our native mechanics could not have produced if they had only thought—but then, thinking is the hardest work a mechanic does. We recognize the ingenuity of these American machines, the skillful way in which they are devised to get over difficulties and to produce mechanically the maximum result—both in quantity and quality—with the least amount of costly human intervention. The candid Englishman must admire these things, but he is apt to attribute them wholly to the natural mechanical genius of the American—something natural to the soil, which he summarizes as 'Yankee ingenuity.' Now if in anything genius may be rightly described as 'an infinite capacity for taking pains,' it certainly is so in regard to mechanical design. All these beautiful devices we see in the Pratt and Whitney machines did not flash into the brains of their originators during idle moments like lightning in a summer sky; but, however suddenly the end may have come, they were the results of previous study of what was required, and careful thought as to the best way of producing it. And if this is true of the individual, it is equally so of the corporation or firm to which he belongs. . . . It is hard to account for this higher perfection of light machine tool making on the other side of the Atlantic. We are apt to consider in a new country things are inclined to be hap-hazard and makeshift, but we must not forget that the engineering history of New England extends almost as far back as that of Old England. At any rate the first American designers had all the benefit of our early experience; for come what may, nothing can rob England of the honor of being the birth-place and nursery of modern mechanical engineering."

Our contemporary then offers as one explanation of the superiority of American tools the fact that in England machine tool builders, who were brought up in the shops, are being superseded by their sons, educated in schools where the spirit of mechanical ingenuity is unknown and whose only knowledge of the shops has been obtained by remaining in them long enough to get "a fair knowledge of the work." Another class equally unfitted to lead in machine design is described as the builders who began life as mechanics, and have prospered by dint of frugality until they own works of their own, but whose mental horizon is narrow. Turning to the conditions in this country, our contemporary says:

"The New England mechanic is, however, a different man to his confrere in this country. Whatever may be said about 'there

* See AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL for November, 1896, page 298.

being no more equality in a republic than under a monarchy,' and of the 'aristocracy of the almighty dollar,' or of 'class distinction being as closely marked in America as in England,' there is no doubt that the New England mechanic holds himself more the equal of his employer than does the English craftsman; and, further, that the employer recognizes this claim. The fact has nothing to do with the form of government; in our opinion the root of this healthy feeling is in the method of education, under which the sons of masters and men sit on the same form at school. The influence is good for all; it levels up both classes.

"In regard to the engineering industry, and the machine tool trade in particular, the results have been most fortunate. The sons of employers have entered upon their career with a truer appreciation of the work of the artisan, and the value of shop practice, on which the success of the business must, after all, so largely depend On the other hand, the young artisan sees that his employers are not a race apart, but have characteristics in common with himself, so that it only needs a change of environment to enable him to take his place among them.

"It may be said this is more a social problem than one having any bearing on the machine tool industry. We think otherwise. The nearer approach to social equality between employer and employed—the executive, the drawing office and the bench—leads to a unity which is strength. The American workman speaks out more boldly, he ventures to differ more emphatically, or rather he differs without the thought that he is venturing, and holds his point firmly. On the other hand, the employer is not afraid to discuss matters with his workmen; he does not feel he loses caste by arguing the matter out, even if he got beaten in the argument. In fact, the two classes meet on an equality which is necessary to perfect council."

In placing so much importance upon the better relations existing between employer and employee in this country, *Engineering* has undoubtedly directed attention to one of the greatest factors in the successes of American tool builders, and we doubt if in any shops the relations are more cordial than in those of the establishment whose excellent tools called forth our contemporary's editorial. The difference between designing carried on by a small corps of men standing alone, and designing which in the long run represents the best thoughts of every brainy man in the establishment, must be great. If any other reason for the present superiority of American machine tools is needed, it can be found in the higher wages paid in this country, the higher plane which a mechanic is thus enabled to occupy, and the incentive thus given to save in the cost of labor by making each hour of labor more productive. This incentive is much greater here than it is abroad. It is so great that it is felt by men of all grades in our engineering and manufacturing establishments, and so we find a large portion of these well-paid employees heartily co-operating with their employers in the improvement of machinery for making labor more productive or doing away with it altogether in certain operations. May the good wages prevalent in this country and the better standing of the employed never decline, but be ever on the increase.

NOTES.

At a meeting of the Engineers' Club of St. Louis, on January 6, 1897, a paper was read by Mr. F. F. Harrington on "a new testing machine and the cross-breaking test of vitrified brick." The machine was described, and the methods of calibrating it and determining its friction were explained. A number of tests of vitrified paving brick were given and broken specimens were exhibited. In conclusion, standard methods for making the cross-breaking test of vitrified brick were proposed.

Press dispatches of January 20 state that another naval engineer has succumbed to overwork on board our vessels of war. This time it is Fleet Engineer Bumap of the *Olympia*, the flagship of the Asiatic squadron. He is a veteran of the civil war and is closely approaching the compulsory naval age of retirement. He has collapsed under the strain of looking out for the 17,000 horsepower machinery of the *Olympia*, while at the same time exercising the general duties of Fleet Engineer of the squadron.

Chair car No. 1,432, on the Sante Fe route, is equipped with the new system of electric lighting, the current being generated from the car axle. This car made about 2,400 miles in local service and was then put on trains Nos. 5 and 6 in the Chicago-Denver service. On the first trip it ran through a heavy rainstorm, followed by freezing weather and a snow storm in the West. Notwithstanding this, it completed its first round trip of 2,418 miles It is now running regularly in this service. The Chicago, Burlington & Quincy Railroad has had two experts on this car ever since it began running to Denver. When the train is running, the light is taken direct from the dynamo, and when running at less speed than eight miles per hour, or standing still, it is taken automatically from the storage batteries.

A novel method of compressing air is employed by the Taylor Hydraulic Air Compressing Company, of Canada. A falling column of water is made to entrain air which is compressed by the weight of the surrounding water and when the water reaches the lower level it enters an air chamber where the air separates from it and is stored above it ready for use just as steam occupies the steam space of a boiler. A 150 horse-power installation on this principle has been put in for the Dominion Cotton Mills at Magog, near Montreal. It has been operating since last September without a hitch. The beauty of the thing lies in the fact that there is no moving machinery in the air compressing outfit—only a column of falling water.

Our readers will remember that in 1892 the Illinois Central Railroad investigated the desirability of using electricity in its suburban service and for handling the World's Fair traffic on its suburban tracks. In a recent discussion on electric traction before the Western Society of Engineers, Mr. H. W. Parkhurst presented the estimates made at that time. They are now, of course, five years out of date, so to speak, but they are not without interest. The estimates include power plant, line, motors and cars, but not track. The first estimate is for handling 12,000 passengers per hour in four-car trains at a speed of 20 miles per hour over a track 7½ miles long, with the trains running around loops at each terminal. The capital expenditure would have been $812,000 and the daily operating expenses $750.40. The next estimate is on the same basis, except that 18,000 passengers were to be handled per hour. The capital invested would have had to be $1,220,900 and the daily running expenses $1,095.10. For 24,000 passengers per hour the figures would have been $1,624,200 and $1,456.95 respectively. The fourth estimate was based on carrying passengers at the rate of 12,000 per hour from 6 a. m. to 3 p. m. and between 7 and 12 p. m., at the rate of 18,000 per hour from 3 to 5 p. m. and 24,000 per hour from 5 to 7 p. m. The capital expenditure was put at $1,564,200 and the daily expenses $1,105.60. Then follows a comparative statement of steam and electric power for handling the regular suburban service, in which it is shown that electricity would require an expenditure of $1,847,500 in capital as against $1,584,000 for steam. On the other hand, the daily operating expenses for electricity are put at $1,813.75 and for steam $2,032.46. It should be stated that the operating expenses include interest and maintenance in each case. Those who desire to see the figures in greater detal can find them in the journal of the society for December, 1896.

In his recent annual report, Commodore Melville says, regarding the new cylindrical boilers for the *Chicago*: "The completion of the boilers has been delayed owing to failure to obtain the nickel-steel plates originally ordered, and to further delays consequent on the failure of the manufacturers to deliver within reasonable time enough shell plates of nickel steel of a satisfactory finish to complete one of the cylindrical boilers. The working of the nickel steel plate finally accepted for one boiler has also involved some delay, and the experiment, as a whole, has added considerably to the cost of manufacture of the cylindrical boilers." The Secretary of the Navy in his report refers to the same subject in these words: "When the cylindrical boilers for the *Chicago* were being designed, the Department sanctioned the use of nickel steel for the shell plates, but the plates received from the contractors were of such a character that grave doubts existed as to whether they could be used, on account of uneven surfaces. The manufacturers experienced such difficulty in getting satisfactory plates that the Department eventually decided to build but one of these boilers of this material, and to construct the others of the ordinary carbon steel. The physical tests of the nickel-steel plates were all that could be desired, and it is confidently anticipated that the makers will eventually overcome the difficulty that has been experienced in making smooth surfaces. When this is done, a material reduction in the thickness of boiler plates will be practicable."

Personals.

Mr. Ed. D. Robbins, of Hartford, Conn., has been chosen Vice-President of the New England Railroad.

Mr. Eugene S. McCarty, General Manager of the St. Louis, Cape Girardeau & Fort Smith, has resigned.

Mr. E. M. Poston, of Nelsonville, O., has been appointed Receiver of the Columbus, Sandusky & Hocking.

Mr. B. F. Johnson has been chosen President of the Chicago, Paducah & Memphis, vice Mr. W. L. Huse, resigned.

Mr. Morgan Jones, previously General Manager, has been elected President of the Fort Worth & Denver City.

Mr. William V. Reynolds, Receiver of the Lebanon Springs Railroad, died suddenly in New York City last month.

Mr. F. F. Lyons has been appointed Chief Engineer of the East Broad Top Railroad, with headquarters at Rockhill Furnace Pa.

Mr. S. Wesselius, of Grand Rapids, Mich., has been appointed Railroad Commissioner of Michigan, to succeed Mr. S. R. Billings.

Mr. John A. Graves has been appointed Purchasing Agent of the Hutchison & Southern, with headquarters at Hutchinson, Kan.

Mr. W. E. Sells, of New York, has been chosen Vice-President of the Chesapeake & Western, with office at 30 Broad street, New York.

Colonel Ashley W. Cole has been appointed a State Railroad Commissioner of New York, to succeed Samuel A. Beardsley, resigned.

Mr. Charles D. Owens, Vice-President and General Manager of the Atlantic & Danville Railway, died suddenly, Jan. 15, at Norfolk, Va.

Mr. H. K. Gilbert, until Jan. 1, Auditor of the Crane Company, of Chicago, has been elected Treasurer of the Sargent Company Chicago.

Mr. E. W. Knapp has resigned as Master Mechanic of the Mexican National to accept a similar position on the Interoceanic-Puebla Railway.

Mr. J. N. Beckley, of Rochester, N. Y., Vice-President of the Toronto, Hamilton & Buffalo Ry., has been chosen President, vice Mr. S. E. Peabody.

Mr. Wm. P. Ijams has resigned as President of the Belt Railroad & Stock Yards Company, Indianapolis, Ind., and Mr. D. F. Kinshall succeeds him.

Mr. George Dullnig has been appointed Receiver and General Manager of the San Antonio & Gulf Shore road, in Texas, in place of Mr. Henry Terrall.

Mr. John F. Barnard, of Omaha, Neb., Receiver of the Omaha & St. Louis, has also been appointed Receiver of the St. Clair, Madison & St. Louis Belt Line.

Mr. G. A. Woodman, late of the Illinois Central, has been appointed Superintendent of the car department of the Lima Locomotive and Machine Company, Lima, O.

Mr. H. C. Frick, of the H. C. Frick Coke Company, has been elected President of the Youghiogheny Northern and the Mount Pleasant & Latrobe railroads in Pennsylvania.

Mr. Albert M. King, who has filled the position of General Superintendent of the Jackson & Sharp Company's Works for 18 years, died suddenly on New Year's night, of heart disease, age 48 years.

Mr. H. C. Smith, Master Mechanic on the Delaware & Hudson, at Oneonta, N. Y., has resigned, and Mr. J. R. Skinner, Master Car Builder at the same place, has been put in charge of both departments.

Mr. George A. Hancock has resigned as Superintendent of Machinery of the Gulf, Colorado & Santa Fe to take the position of Assistant Superintendent of machinery of the Atchison, Topeka & Santa Fe, with headquarters at Topeka.

Mr. Myron T. Herrick, of Cleveland, and Mr. Robert Blickensderfer, of Toledo, were last week appointed Receivers of the Wheeling & Lake Erie road. Mr. Blickensderfer is the General Superintendent of the Wheeling & Lake Erie.

Mr. William Smith, formerly Superintendent of Motive Power and Machinery of the Chicago & Northwestern, has been appointed Master Mechanic of the Duluth, Missabe & Northern, a position heretofore held by Mr. A. F. Priest.

At a meeting of the directors of the New York, New Haven & Hartford Railroad, Jan. 11, the position of Third Vice-President was formally declared abolished, and Collin M. Ingersoll was appointed assistant to the President, with office at Park Square Station, Boston.

Mr. W. H. Fry died in St. Louis last month. Mr. Fry was for several years Superintendent of the car department of the N. Y., N. H. & H. R. R., but was better known through his service with the Pullman Palace Car Company, with which he had been connected before going to New Haven.

Mr. W. H. Bancroft, General Superintendent of the Mountain Division of the Union Pacific, has become General Manager of the Oregon Short Line & Utah Northern, which was sold under foreclosure Jan. 9, and which will hereafter be operated with an independent management.

Mr. Charles M. Heald, Receiver and General Manager of the Detroit, Lansing & Northern, has been chosen President of the reorganized company, which is to be known as the Detroit, Grand Rapids & Western. Mr. E. V. R. Thayer has been chosen Vice-President and Mr. Charles Merriam Secretary and Treasurer.

Mr. H. Monkhouse has been appointed Superintendent of Machinery of the Chicago & Alton, with headquarters at Bloomington, Ill., in place of Mr. Jacob Johann, resigned. Mr. Monkhouse has been with the Chicago, Rock Island & Pacific since October, 1889, and since June, 1891, has been Assistant Superintendent of Motive Power of the road.

Mr. W. R. Stirling, who resigned the position of First Vice-President of the Illinois Steel Company last spring, in order to take charge of the affairs of the Universal Construction Company has now resigned the Presidency of that company, intending to associate himself with another line of business. Before doing so, however, Mr. Stirling intends to make a long-expected trip to Europe.

Mr. H. B. Hodges has been appointed Purchasing Agent of the Long Island Railroad in place of Mr. Geo. L. Hubbell, resigned. Mr. Hodges will also have the additional duties and title of Superintendent of Tests, and will arrange for and have general supervision of the inspection and testing of supplies purchased, as well as of tests in actual service, and will issue specifications covering the material to be inspected.

Sir Joseph Hickson, formerly General Manager of the Grand Trunk, died at Montreal, Que., Jan. 4, aged 66 years. He entered railway service in England, and came to America in 1862, taking a position with the Grand Trunk as Chief Accountant. Four years later he was chosen Secretary and Treasurer, which position he held until he was appointed General Manager in 1874. He resigned the latter position Jan. 1, 1891.

Mr. F. L. Wanklyn, Works Manager in the Grand Trunk Railway shops at Montreal, has resigned that position after fifteen years in the service of that company, during thirteen and a half of which he has been the manager of the shops. Mr. Wanklyn has accepted the position of Manager of the Toronto Railway Company, which has some eighty miles of electric railway running in and around the city of Toronto.

Mr. Jacob Johann, Superintendent of Machinery of the Chicago & Alton Railroad, has resigned. Mr. Johann has completed one-half of a century of service in locomotive and car work, from 1847 to 1897, and after this long period of activity he retires to his home in Springfield, Ill., where he will always be glad to receive and entertain his friends. May he long be spared to meet those friends and the many railroad men who honor him for his ability and personal qualities.

The following changes in the mechanical department of the Grand Trunk took effect Jan. 1: Eastern and Northern divisions—Mr. Frank Joy is appointed Assistant Master Mechanic, Gorham, N. H., vice Mr. R. Patterson, transferred; Mr. W. Ball, Foreman, Belleville, Ont., vice Mr. W. D. Robb, promoted; Mr. W. Price, Locomotive Foreman, Toronto, Ont.; Mr. J. McGrath, Foreman Repair Shop, Toronto, Ont., vice Mr. W. Ball, transferred; Mr. Bryce Stimson, Foreman, Gravenhurst, Ont., vice Mr. W. S. Price, transferred. Western Division—Mr. Robert Patterson is appointed General Foreman, Fort Gratiot, Mich., vice Mr. S. Hayward, transferred; Mr. S. Hayward, Locomotive and Tunnel Foreman, Port Huron, Mich., vice Mr. Frank Joy, promoted. Mr. W. D. Robb is appointed Master Mechanic on the Middle Division, with headquarters at London, Ont., vice Mr. A. H. Smith, resigned.

New Publications.

PROCEEDINGS OF THE TWENTY-SEVENTH ANNUAL CONVENTION OF THE MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION, held at New York, September 9, 10 and 11, 1896. Published for the association by the *Railroad Car Journal*, New York. Pages, 118; 6 by 9 inches.

This publication appears in its usual form and contains reports and discussions on subjects of value to every railroad master painter. Among the important subjects treated in this report are the use of compressed air in burning off cars, the flatting of varnish on cars and locomotives, the advisability of painting locomotive jackets: painting galvanized iron, the "enamel process" of painting coaches, painting of a locomotive, painting hot surfaces of locomotives such as dome casings, boiler fronts, etc., the housing of passenger cars, spontaneous combustion in the paint shop, etc., etc. This array of practical subjects are sufficient to indicate the value of the proceedings to others besides the members of the association.

TABLES SHOWING LOSS OF HEAD DUE TO FRICTION OF WATER IN PIPES. By Edward B. Weston, C. E. D. Van Nostrand Company, New York. 170 pages $4\frac{1}{4}$ inches by $6\frac{1}{4}$ inches. $1.50.

The tables in this book are the result of 20 years of experience and investigation by the author. Finding hydraulic formulæ unfavorably criticised, the author endeavored to prove them to his own satisfaction and collected data from 520 experiments. A study of this data convinced the author that the same formula would not apply in all cases and that the data should be divided into three classes, one embracing smooth-bore pipes such as brass and lead, another in which the bore was as smooth as new cast-iron pipes, while the third embraced pipes whose surfaces were in the condition of old cast-iron pipe whose interior was roughened by corrosion. The result of his work was a new formula by the author for smooth pipe, and the acceptance of the formulæ of a French engineer, the late Henry Darcy, as suitable for new cast-iron pipe. A general formula for old cast-iron pipes was not found, but the author gives a series of multipliers to be used in connection with the tables for new cast-iron pipes which will give good approximate results. The two formulæ have been tested and tried and their accuracy established, and upon these the tables in the book are based. The tables for smooth pipe embrace diameters from $\frac{1}{2}$ inch to 3 inches, and those for cast-iron pipe from 1 to 60 inches. Each table has six columns, the first giving the mean velocity of water in feet per second; the second gives the head in feet required to produce this velocity; third, discharge in U. S. gallons per minute; fourth, the loss of head in feed due to friction per 100 feet; fifth, the discharge in U. S. gallons per 24 hours; sixth, the loss of head in feet due to the orifice of influx.

The tables are very complete, the advance from one rate of flow to another being in small increments. The tables are also fully explained and examples of their application given, so that nothing appears to have been omitted that would make the tables valuable to those interested in hydraulics.

A PRIMER OF THE CALCULUS. By E. Sherman Gould, M. Am. Soc. C. E. Van Nostrand Science Series, No. 112. D. Van Nostrand Company, New York.

The word "calculus" in the title of this little book may lead many to decide without further consideration that it is too deep for them. We think, however, that such a conclusion would be too hasty, for the author has dealt with the subject in a brief, simple and effective manner. Furthermore, he confines the work to the rudiments of the science, and anyone willing to make a reasonable effort to obtain a working knowledge of calculus can do so by a study of this book. The author has little to say about the theory of calculus and that little is said after after the reader has gained confidence in the value of the science through an insight into the results obtained from actual work. We advise anyone desiring to take up the study of calculus to study this book.

PROCEEDINGS OF THE FOURTH ANNUAL CONVENTION OF THE NATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION, 1896. 154 pages; 6 inches by 9 inches.

The convention of this society was held in Chicago Sept. 1, 2 and 3, 1896, and a vigorous discussion took place on the papers presented. The papers deal with many subjects of interest to the railroad master blacksmith, such as forges and tuyeres, making of axles, making and repairing locomotive springs, designs of furnaces, making and repairing locomotive frames, gas furnaces, tool steel, etc. In these days so much more attention is being given to railroad blacksmithing that this volume should be of value to every master blacksmith and to some of their superior officers also. It is well gotten up, but a good index to its contents is needed.

Books Received.

YEAR BOOK OF THE U. S. DEPARTMENT OF AGRICULTURE FOR 1895. Washington: Government Printing Office. 1896. 656 pages.

Trade Catalogues.

[In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. These are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

MILLING MACHINES. The Cincinnati Milling Machine Company, Cincinnati, O., December, 1896. 48 pages, 6 by 9 inches. (Standard size.)

For many years this well-known firm has made the manufacture of milling machines an exclusive specialty, and it has been its constant purpose to make its machines excel in their particular line. The catalogue before us illustrates the latest and most improved designs by this company. The first 20 pages are devoted to plain and universal milling machines of various sizes. In each design the column, knee, saddle, table, overhanging arm (with which each is provided), spindle and bearings, are all of great strength and ample proportions for heavy work. In spindle power and strength of feed it is claimed that these machines are unexcelled. The column has a cylindrical brace between the two supports for the overhanging arm, so that the latter is held in what is virtually one long bearing, the metal in which gives great rigidity to the upper part of the machine. Braces are also furnished between the overhanging arm and knee and permit of heavy cutting. All the feeds and adjustments are convenient to the operator. Ball bearings are used on the table feed screw of the No. 3 machine, thus greatly reducing the friction.

The table is provided with a quick return, handles at both ends, and, in fact, nothing seems to be omitted that would add to the convenience or speed of manipulation. The overhanging arm has an adjustable bronze bushing, split in three places and fitted to a taper hole so that all wear can be taken up concentrically. In the universal machines a distinctive feature is the swiveling carriage for the table. This not only adds to the appearance, but is of especial practical value when cutting spirals or any work requiring the setting of the table at an angle. The swiveling carriage need not be drawn out from the face of the column to the same extent as when made square, permitting at the same time the use of a shorter cutter arbor. Again, the swiveling carriage always has a large bearing on slide on top of knee, no matter at what angle the table is set. This permits further a most effective method for clamping the swiveling carriage to slide on knee. These points all add to

the rigidity of the machine. The index for angles or spirals is placed on the outside of the circular carriage where it may be conveniently read. The graduations, being indexed on a circle of large diameter, insure the greatest accuracy. The table may be completely revolved through 360 degrees, and this same feature allows spirals to be cut beyond 45 degrees. It is provided with oil channels and pockets at both ends.

Among the attachments for milling machines illustrated, is a compact universal indexing and dividing head of excellent design, plain indexing centers, rack cutting attachments, an attachment for securing high speed for light milling work, a vertical spindle milling attachment, cam cutting mechanism, a rotary milling table, vises, arbors and milling dogs. This latter is of a form that prevents the inaccuracies that arise in taper work from the gaining and losing of spacing due to the bent tail of the ordinary dog. An illustration of a universal cutter and tool grinder completes the line of machines presented.

The presswork, engraving and paper are beyond criticism, and the whole forms a very neat and artistic piece of catalogue work.

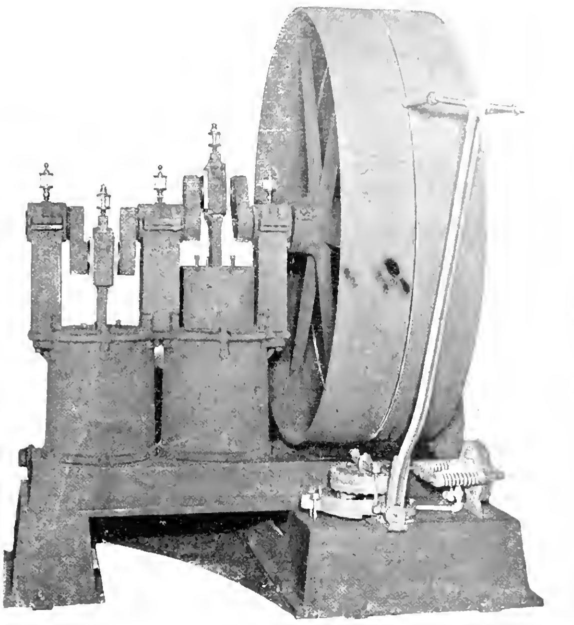
DIXON'S GRAPHITE PRODUCTIONS. Joseph Dixon Crucible Company, Jersey City, N. J., 56 pages, 6 inches by 9 inches. (Standard size.)

This interesting catalogue comes in a bright cover, made so by highly colored views of the company's works at Jersey City, its graphite mills at Ticonderoga, N. Y., and its cedar mills at Crystal River, Florida. Among the graphite productions which are described in its pages is lubricating graphite. The heavy and high speed machinery of modern times has made the question of lubrication an important one. Our readers hardly need to be told that pure flake graphite has proved one of the most satisfactory of lubricants under these modern conditions. For engine cylinders it can be used dry or mixed with a little water or oil. As a remedy for heated bearings it is a great success. In locomotive works it has made an excellent record—in the cylinders, steam chests, air pumps, on bearings, crank pins, etc. The company also make "graphited lubricants," the basis of which is pure flake graphite, and to which is added a good grease that serves the purpose of holding the graphite and distributing it on the surface to be lubricated. These lubricants are fully described in the pages of this catalogue.

Another production is a pipe-joint compound that is claimed to be better than red lead and cheaper also. Still another and very important material into which graphite enters is Dixon's Silica-graphite paint, which has an enviable record extending over twenty-five years. Silica and graphite form the pigment, and the oil is kettle-boiled linseed oil. Roofs and exposed metal surfaces painted with this material have lasted 15 or 20 years without repainting. It has great covering qualities and is untouched by heat, cold, dampness, salt air, alkalies or acids. A gallon ready mixed for the brush will cover 600 square feet (one coat) of metal surface.

Among the other graphite productions listed in this catalogue, we might mention graphite cycle preparations, electrotyping graphite, Dixon's famous crucibles, phosphorous chargers, founder's core wash, plumbago facings, crucible clay and graphite mixture, belt dressing, and last but not least, the widely known Dixon's American graphite pencils, which we have no hesitation in saying are the best made. We advise our readers to write for one of these catalogues and learn in greater detail than we can give here the value of these graphite productions.

The Richards Automatic Belt-Driven Air Compressor.



The Richards Automatic Belt-Driven Air Compressor.

The field for a belt-driven air compressor that shall be entirely automatic and require no attention is so evident that we need not enlarge upon it. For many shops of moderate size in which compressed air is needed it furnishes the cheapest and best method of getting the air. The machine here shown is entirely automatic. It has two 10 by 10-inch cylinders, placed vertically, with their pistons driven by cranks on a horizontal shaft above them. The belt pulleys are 56 inches in diameter and 8 inches face. The cylinders are not compounded, because it is believed that the gain in the absence of an intercooler is inappreciable. The inlet valves are vulcanite disks and very light—less than an ounce each in weight. The delivery valves are of steel.

The normal position of the belt shipper is with the belt on the driving pulley, and it is drawn into that position by springs. The vertical diaphragm at the right of the shipper is piped to the air reservoir, and when the pressure rises to a predetermined figure the diaphragm overcomes the springs seen on each side of it, and in its movement operates a slide valve in that part of the case seen between the springs. This admits air to the second diaphragm which is connected to the shipper, and which it operates against the resistance of springs located in the base of the machine and attached to the horizontal lever under the diaphragm. When the pressure falls the vertical diaphragm moves the slide valve and puts the horizontal diaphragm in connection with the atmosphere, and then the springs in the base of the machine pull the shipper over and the compressor starts again.

The compressor is from designs by Mr. Frank Richards, and patents have been applied for. It is made and sold by Mr. M. C. Hammett, of Troy, N. Y. Three of these machines have been in successful operation for months in the shops of the Lake Shore Road, and another in the shops of the New York, Ontario & Western Road.

The Neafie Insulated Joint.

The Neafie Insulated Joint, shown in the accompanying illustrations, is a truss plate or chair of iron or steel, bent with sides inclined upwardly. Upon this plate rest the ends of the two rails, between which it is usual to place vulcanized fiber or a wooden washer. The rails do not rest directly upon the truss plate, but upon an insulating plate, seen in Fig. 3. Under this is a metal plate, slightly thinner than the insulating plate, contiguous to the latter, so as to transmit the concussion of car and locomotive wheels mov-

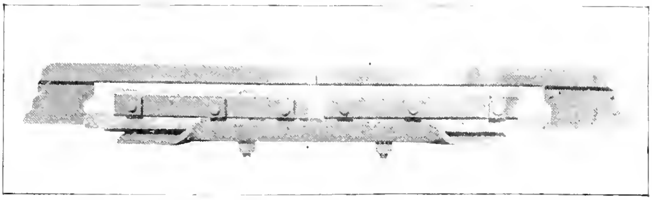


Fig. 1

Fig. 2.

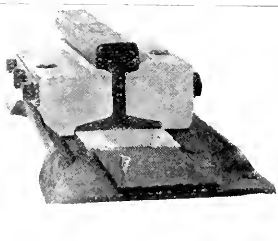


Fig. 3.

The Neafie Insulated Rail Joint.

ing across the rail joint from the insulating to the metal plate and, at the same time, preserve the insulation of the joint.

In addition to the above, there are wooden blocks and iron plates to splice or bind the ends of the rails; these splice bars are secured to the iron plate or chair by four vertical bolts, and when these are screwed up the splice bars are brought to bear hard upon the inclined surfaces or side of the chair or truss plate, thus making impossible the spreading apart of the rails. The usual number of fish-plate bolts and nuts are also used in securing the wooden blocks to the rail. These joints are equipped with Kleman patent nut locks and washers throughout, and in this way the loosening of nuts upon bolts is prevented.

When the joint is thus put together it forms a perfectly insulated one, as well as giving strength and support to the ends of the rails.

Regarding the life of the joints, it is stated that they have been in continuous use on several of our great railroad systems for upward of two years, and reports show that they are still in first-class condition, and the cost of maintenance has been little or nothing.

The manufacturers are the Allison Manufacturing Company, which has just completed arrangements for the sole manufacture of this joint in the United States, and Mr. J. S. Brewer, 1030 Monadnock Block, Chicago, has been appointed its representative for the State of Illinois and Milwaukee. The joints have been largely used on the Delaware, Lackawanna & Western Railroad and Pennsylvania Railroad for upward of two years, with most satisfactory results, and are on trial on many of the other roads, such as the Lehigh Valley; Chicago, Burlington & Quincy; Chicago, Rock Island & Pacific, and Chicago and Northern Pacific.

The Progress in the Manufacture of Iron and Steel in America and the Relations of the Engineer To It.*

BY JOHN FRITZ, BETHLEHEM, PA.

(Continued from page 30.)

My father being a millwright and machinist, as well as a small farmer, did all the important repairs for all the mills; in this shop consequently I spent all the spare time I could get off the farm, and it was a rare treat for me to get there. The tools consisted of two small lathes for turning iron and one for turning wood; all of them had wooden "shears" or beds. There was also a machine for cutting light gears, which to me was a great curiosity; there were several vises, and quite a number of small tools; one they called a "doctor," which was used to correct "drunken threads," as all screws of any importance were cut with the chaser. A few years later I frequently wished I had one of them to straighten up some crooked threads that I would unfortunately get on my hands.

In 1838 I went to learn my trade. In the machine shop there were about the same number and character of lathes as in the shop mentioned, but they were larger, one of them being a double-ender, for the purpose of boring out wheels that were too large to swing over the shears. There was also a drill press, made out of a lathe-head casting, bolted against a 12 by 12 inch wooden post; it was not a very sightly machine, but it did good work for the time. The shop made small brass castings, built small boilers and small engines, and did all kinds of country machine and blacksmith work; made our own patterns, without any drawings. It was from this shop that I was sent out from time to time to do some repairs at the small charcoal furnaces, forges and mills. The rough training I had at this primitive shop proved of great value to me in after life.

In 1854 I went to the Cambria Iron Works at Johnstown, and well knowing the importance of having good tools for the completion and perfection of such a plant as that was intended to be, I earnestly urged the company to get some of the best tools that were built, which they consented to, and at the same time had some special lathes built, and made much heavier than any that had been previously designed. This was the commencement of a better class of tools about an iron works, and facilitated the great improvements which soon after took place. But this is over 40 years ago, and what was a good tool at that time is a very indifferent one to-day, as the machine-shop equipments have fully kept pace with the times. The builders have not only perfected the machines in general use, by making them heavier, more powerful and more convenient, but they are building special tools for almost all manner of purposes, which greatly facilitates, perfects and cheapens the work, and renders it possible to get parts of a machine made in different shops, and have them all fit together as though they had all been made in one place.

I look back to my early days in the shop, now nearly sixty years ago, and call to my mind the equipments of the shop in the way of tools which I have already described, and compare the facilities for making drawings of to-day with those at that time, when the complete outfit consisted of a board, a carpenter's square, a pair of compasses, a bevel, a lead pencil, and a piece of chalk, and a jack plane to prepare the board for another drawing. After at time we adopted the plan of making models in skeleton, full size, especially when any motion was to be worked out, and also made, when it was possible, all the drawings full size; when too large to admit of this, would make important sections full size, and this practice I am not ashamed to follow at the present time, as it has many advantages.

The small shop tools for a lathe consisted of a hook tool with a sharp tit on the bottom to hold it on the rest (which was made of soft wrought iron); the tool was made out of a steel bar about ⅜ by ¾ inch, generally put in a wooden stock some 2½ inches in diameter, with a handle on the lower side, as you see on the wall. In addition to the tool just described, there was a finishing tool made in the shape of a spike-head, cutting edge on both sides, one to do the cutting or finishing, and the other to keep it in position on the rest; it also has a wooden handle, but of different construction from the handle of the hook tool, as it was held against the shoulder instead of under the arm; next was a chaser, and last, as usual, was the "doctor," to cure in a measure "drunken threads," which frequently occurred. The small tools consisted of a pair of outside and an an inside pair of calipers, a file and a steel straight-edge (home-made), 12 inches long, and was divided into inches, ½ inch, ¼ inch, ⅛ inch, 1/16 inch, and one of the inches was divided into 32nds, and was used for measuring, as well as for a straight-edge.

Now let us for a moment note the equipments of a modern machine shop for comparison. First, they have a great drawing room, and a good corps of men well skilled in their art, and are equipped with everything that is essential for producing work correctly and quickly, with blue prints by the score. The machine shop of to-day is a marvel in completeness of equipments for doing work correctly and with rapidity, having special small tools for all purposes. The accuracy with which their round gages are fitted up is such that a machinist of fifty years ago could not possibly realize how it could be done. Suppose you could have in his presence separated a 1-inch gage, and held the plug in your hand for a few moments, without calling his attention to it; then hand it back and request him to put it in its place again, and find he could not get them together, he would think there were some old-time witches about.

The latter part of the present century is remarkable for the success attained in designing and perfecting instruments and methods for correcting the old and imperfect system of former years. The invention and construction of instruments of precision and the methods of their calibration and adjustments, which enable measurements to be taken within one ten-thousandth of an inch; machines for measuring tapers, which enable the mechanic to fit taper work with almost the same perfection and facility as parallel work or refinement of practice peculiar to modern times, and of which a mechanic of 50 years ago could have no conception, either of their possibility or practical value.

The great improvement which has taken place in the manufacture of steel, both in quality and quantity, and its general adoption in machine building; the using of steel higher in carbon, the introduction of nickel, and the treatment by oil tempering, have rendered the tools I have already referred to, practically useless for a very large part of the work that is now being done; consequently new tools are required that are much heavier and more powerful than any that had been built up to this time.

The Bethlehem Iron Company has 4 lathes in use, all of the

* President's address before the American Society of Mechanical Engineers.

same pattern; 1 of them is used for what is called a cutting-off lathe, and frequently employs 12 tools, 6 on each side, made out of the best steel that can be had, size 1 inch by 6 inches, and are forced to cut all they will stand. These lathes have had work in them weighing over 190,000 pounds. They have planers that have finished castings that each weighed 165 tons, and the finishing of of nickel-steel armor plate requires tools of great power and special design.

The workmanship on the cranks and shafting has to be of the highest order, consequently the machines on which they are finished have to be massive and of great power, and fitted up in the best possible manner; the journals of the shaft must be round and perfectly parallel, and the flanges must be true with the axis or body of the shaft, and the parts generally have to be interchangeable, the flanges being plain on the face, relying entirely on the bolts in the flanges to keep true to each other. This requires handwork of a very fine order. Shafts 18 or 20 inches diameter, 60 or 70 feet or more in length, all bolted solidly together, laying in V's, can be turned easily by one man with a lever of 36 inches in length; this proves the high character of the work.

In speaking the manufactured products of iron and steel, I shall take up first the subject of forgings made of iron. These were originally made out of faggots (bundles of iron bars) heated in a reverberatory furnace, and welded and shaped under a hammer which was generally too light; the force of the blow did not reach the center, and the result was that forgings of any considerable size were unsound in the middle. This occurred to such an extent that, in my early connection with machinery, I discarded forged shafts entirely and substituted cast iron melted in an air furnace, and continued to use it, with one single exception, until we learned how to make, heat, forge and treat steel in such a manner as to practically get it solid and free from internal strains, and was ready to recommend it as the proper material for shafts and miscellaneous forgings.

I have known the early wrought-iron shafts to fail and be replaced by cast iron, which, never gave any trouble, and a practical person giving the subject any serious consideration will see at once why a cast-iron shaft should be better and safer than wrought iron, as they were made.

In the first place, you can, by the use of the proper kind of pig iron, intelligently melted in an air furnace, get a tensile strength of 32,000 pounds per square inch, and, with a proper sink-head you can get practically a solid casting, and I might add homogeneous and close in the grain; while, as I have already stated, the forged shaft will, in all probability, be unsound in the center and coarse in the grain, and its tensile strength will be little if any greater than cast iron.

I shall now refer to the single exception which I have alluded to, believing a brief description of the shafts, and give the reason why I used wrought iron and steel in place of cast iron, which had served me so well for a period of nearly fifty years will be interesting and instructive to you all. First, the reason for using wrought iron and steel in place of cast iron was, I wanted a three-throw crank for a three-cylinder engine, and had to use a built-up crank; at that time a solid forged crank of such dimensions as was needed could not have been made in this country. The stroke of the engine being short, reduced the distance from center of shaft to the center of crank pin to such an extent that I was compelled to reduce the diameter of the shafts to the smallest size consistent with safety in order to get sufficient metal between the holes in the crank to give the required strength. Steel at that time being more expensive than wrought iron, it was economy to use iron when it would answer the purpose. I concluded to use steel for the main shaft and the first crank pin, and the others wrought iron. The iron shafts and crank pins were from, what I considered at that time, the best forge plant in the country. Having had some previous experience in a small way with both metals, and the results not being altogether lovely, I thought it prudent to see in what condition the metal in the center of these forgings was. In order to show this, a hole about 4 inches in diameter was bored through the center of them all, seven in number, and all were unsound in the center; in the iron the imperfections ran longitudinally, and the four-inch hole practically cleaned them out. The steel shaft, which was about 14 inches in diameter and some 12 feet in length, proved unsound in the 4-inch hole, and showed serious imperfections in the form of large cracks or openings running, as it were circumferentially on the inside of the shaft; the hole was enlarged to about six and one-half inches in diameter, and some of the imperfections were still visible. The position of the shaft was such when in use that, should it give way, it would not be likely to do any serious damage; so we concluded to use it. When the hole was bored through the steel crank pin it showed so badly that we split it in two lengthwise. It was full of cracks, some of them extending almost to the outer edge. Its condition was frightful to a person who was contemplating the building of a large plant for the purpose of making steel forgings, as I was at that time. My experience in making steel, in heating, rolling and forging, had already convinced me that it would require great skill, and still greater care, to prevent imperfections in the interior of steel forgings, yet I was not prepared to witness anything approaching the condition which the splitting of this forging revealed. The chemical analysis, as I remember, was fairly good. There had been some blow holes in the ingot, as there are in too many of them. To my mind the trouble was almost entirely due to two causes; first, the ingot had been put into a hot furnace and heated up too rapidly, pulling the center apart, causing internal ruptures; secondly, by being forged under a light hammer, in all probability using steam on top of piston, which gives a quick stroke and does not give the metal time to flow or the force of it to reach the center of the ingot, consequently elongating the outside more rapidly than the interior, and the importations, whatever they may be, are always the weaker parts and the effect of the blow on the outside elongates them, as it were, by pulling them apart more rapidly than the sound outside of the ingot; consequently the imperfections were greatly augmented.

Mr. W. F. Durfee, in a paper read before the Franklin Institute on the "Conditions which Cause Wrought Iron to be Fibrous and Steel Low in Carbon to be Crystalline"—and a most admirable paper it is, and one which every maker and user of steel should read and study, in regard to unsound ingots—says: "It is a common opinion that one of the reasons why steel forgings are often found hollow in the interior is the failure to work them under a sufficiently heavy hammer, but no hammer, not even the hammer of Thor, can do no more than aggravate the evil of internal ruptures of ingots in steel." This is well said, and is a truth that cannot be gainsaid. It was due to imperfect or unsound ingots, lack of knowledge in heating, in forging, and also the want of proper skill to treat the forgings properly, after they were made, that caused so many failures in the early days of its manufacture, which made many people think and believe that there was some mysterious uncertainty in the metal and discard its use altogether; and to some extent this impression is still in existence, for, to my surprise, only a short time since quite a prominent engineer said to me that he was still using wrought-iron shafts on account of the uncertainty of steel forgings. To those persons who were using steel low in carbon, for various purposes, I urged the use of a higher grade of steel, well knowing it would answer their purpose better; I was answered by the saying that it required too high a grade of skill to utilize it; they must have a material that any one could handle; consequently the steel was so low in carbon that it was no better than iron, and in many instances not as good. My own early experience having fully convinced me that nearly all the failures were due to the use of improper kind and grade of steel, being too low in carbon, and in most instances so high in phosphorus and sulphur that nothing but failure could be expected, yet it was useless to attempt to convince many that a higher carbon steel of proper analysis would answer their purpose. They said no; we are going back to iron; we know what that is, and we can trust it. I was told that a machinist had let a locomotive crank pin fall off his shoulder on the shop floor and it broke in two pieces, and I could readily imagine that a condition could exist that would render it liable to break from the most trifling cause. I also was told that in pinching a locomotive back and forth in the shop, in order to set the valves, that a steel crank pin was broken and many other mysterious cases, as the laymen called them, were reported. At all events, the general condition of steel forgings was such that it was not safe to use them where loss of life might result from failure. I have already alluded to phosphorus and sulphur as most deleterious elements in steel. There are, however, still some people who contend that its presence to an extent not in excess of twelve one-hundredths (.12) will do no harm in low steel, and I have been told quite recently that a person who posed as a mechanical engineer, and a steel maker, endorsed that position; and he may be both, but I will take this occasion to put myself on record by saying that I have no use for it in any shape or form whatever; by keeping it low you can increase the carbon, which is in the right direction for good steel.

Having shown you something of the character of steel in its early days, and its failures, and the disrepute into which it fell, let us suppose the mechanical engineers, who at that time were the men who had charge of the practical part of the steel business, would have said that steel was no good, and dropped it, and said we will go back to the old concrete of metal and cinder again—then where would we have been to day; but they did nothing of the kind, and let me tell you the mechanical engineer of that day was not made of that kind of material, for the engineers who, in face of the prejudices of a continent, advocated the substitution of steel for iron were men who regarded obstacles and prejudices as things which were made to be conquered. He took off his coat, called to his aid that all important adjunct to steel-makers, the chemist, and then went to work as he had done many times before when things looked equally discouraging, and produced the grandest material for construction purposes that the world has ever known, and which will enable engineers to solve great constructive problems, that, but for the improvements in the art of steel making, could not have been accomplished.

Now, after all the labor, anxiety, vexations and disappointments that have been suffered, and in the face of the final success, are we to be told that it cannot be used, because it requires too much skill and careful treatment in both forge and shop? I sincerely hope and believe that we are not. But there is another all important feature on this subject, and that is the practical knowledge which is necessary in order to select the proper quality of steel to be used for the various purposes which it is to be applied to, and the want of this knowledge has been the cause of many failures, and this knowledge can only be obtained by a large practical experience. When I say proper quality of steel for various purposes, I do not mean steel alone low in phosphorus and sulphur (for all steels should be low in both these obnoxious elements), but what I mean is the proper amount of carbon to suit the physical conditions which it will be called upon to endure, and in this experience must be our guide. Fortunately, much experience has already been obtained, so that there ought to be but little excuse for mistakes and failures.

It is not the object of this paper to enumerate the various purposes which steel should be used for, or to indicate the proper amount or grade of carbon to suit the various and changeable conditions that it will be subjected to, but simply to call your attention to the importance of proper selection.

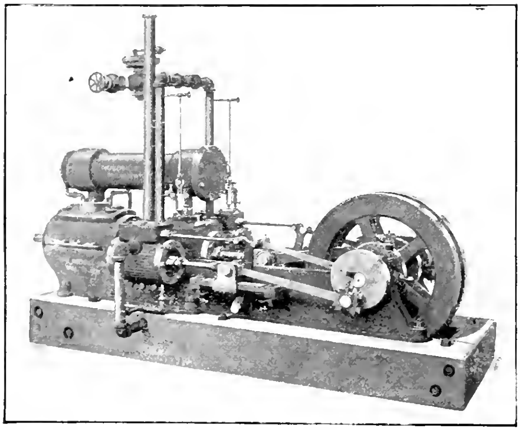
I will now speak briefly of the subject of forging hollow steel shafts, as none other should be used. If not large enough in diameter to forge hollow, let them be bored out and properly annealed. Next I will call your particular attention to the all-important matter of the system to be adopted. While I was contemplating the design of a forging plant for making both light and heavy forgings, fortunately I met Lieutenant Jaques, U. S. N., who was secretary of the American Gun Foundry Board, and had just

returned from abroad, where the Board had been inspecting the naval armaments of Europe, and had also investigated the various systems of forging gun material, and he was so highly impressed with the Whitworth hydraulic system of forging that he made arrangements with Sir Joseph Whitworth & Company, Limited, of Manchester, England, for the machinery for a complete forging plant, to be erected in any place in the United States and by any parties that he might desire to make arrangements with. Shortly after Lieutenant Jaques' return he visited Bethlehem, and told me what he had seen done in the way of hollow forging. I was so impressed with his account that I at once advised the Bethlehem Iron Company to make arrangements for the machinery for a complete plant, which, after a time, they concluded to do, and through Lieutenant Jaques a contract was entered into with Sir Joseph Whitworth & Company, Limited, for the machinery for a complete forging plant. It is to Sir Joseph Whitworth and his able superintendent, Mr. M. Gledhill, that the world is indebted for the most perfect system for forging that has ever been devised, and to Lieutenant Jaques the credit is largely due for its introduction into this country. In connection with the forging plant was included a hydraulic compression plant, under which the fluid steel is compressed during its solidification, which practically prevents cracks, piping and blow-holes, and greatly reduces segregation, which are vital considerations in the manufacture of steel ingots. An imperfect ingot caused by piping or cracks should be condemned to remelting.

(To be Continued.)

The Ingersoll-Sergeant "Triple" Air Compressor.

The accompanying engraving illustrates one of the latest designs of steam-actuated air compressors by the Ingersoll-Sergeant Drill Company of New York. It is called a triple type air compressor, not because the compression is in three stages, but because there are three cranks. By this arrangement dead points are avoided and the machine will start promptly in any position; furthermore the angles between the crank driving the air pistons and those connected to the steam pistons, is such that the greatest rotative effect is obtained when the resistance in the air cylinder is at a maximum. This is the very reverse of the conditions existing in the ordinary straight line compressor. The absence of dead points and the nicer adjustment of work to resistance throughout each



Ingersoll-Sergent Triple Air Compressor.

revolution also make it possible to govern the compressor automatically, making it slow down or even stop as the consumption of air decreases, and to start again when the air pressure falls.

The air cylinders are compounded and are placed tandem, in the center of the machine, connecting to a crank between the fly-wheels. These cylinders are $12\frac{1}{4}$ and $7\frac{1}{4}$ inches in diameter and 9 inches stroke. There are two steam cylinders, each 7 inches in diameter and 9 inches stroke, placed on each side of the air cylinders and driving the main shaft by cranks 90 degrees from each other, and 135 degrees from the air compressing crank. The steam distribution is by means of plain slide valves.

The compressor is built to deliver air at 75 pounds' gage pressure, using steam at 90 pounds' pressure, and to run at 150 revolutions, at which speed it will compress 175 cubic feet of free air per minute. The proportions of the air cylinders may be varied for other delivery pressures that may be desired, and if so ordered the steam cylinders may be compounded. The air cylinders and cylinder heads are water jacketed, and an intercooler is used. The piston inlet valve employed so extensively by this firm is used on this compressor.

The machine is self-contained and very compact, and the workmanship is up to the high standard of this company.

Relative Wear of Copper and Zinc Alloys.

Engineering says that some experiments were recently made in France on the resistance of alloys of copper and zinc to wear. The method followed was to construct rectangular prisms of the samples to be examined, and press it by means of a definite load against a lapidary's wheel fed with "three-minute" emery mixed with oil. The amount removed by the grinding action was then ascertained by finding the weight lost by the sample. The usual routine was to take three samples of the metal to be tested and one of soft copper, each specimen measuring 5 millimeters square by 8 millimeters high. The four were then fixed to the bottom of loaded rods placed vertically over the wheel, so that the center of each specimen lay on a circle of 11 centimeters radius. The wheel was then run for two periods of 10 minutes each at a speed of 800 to 1,000 turns per minute. Taking copper as standard, the following results were obtained for the copper-zinc alloys:

Percentage of zinc.	Relative wear.	Percentage of zinc.	Relative wear.
0	1.000	40.4	1.031
10.1	.846	41.7	1.075
18.4	.861	44.7	1.148
27.1	.905	49.7	1.240
30.2	.929	60.1	Fragile
32.3	.940	80.1	.586
34.7	.950	99.6	.777
37.6	1.003		

CONSTRUCTION AND MAINTENANCE OF RAILWAY CAR EQUIPMENT.—X.

BY OSCAR ANTZ.

(Continued from page 29.)

FREIGHT CARS.

In a previous article the general construction of the floor frame of ordinary freight cars was described and subsequent articles treated of those parts, which, with perhaps slight modifications, are common to most if not all classes: it now remains to describe the different kinds of freight cars which are in use.

FLAT OR PLATFORM CARS.

The simplest kind of car which can be constructed on the floor frame which has been described is the flat or platform car, which consists of the frame, draftgear, trucks and brakes, with perhaps some provision to prevent the material which is carried from falling off the car. These cars are used principally for transporting pieces of freight which are too bulky to put into any other kind of car, and which, from their nature, are not liable to be injured by the weather, and which, from their size and weight, are not likely to be pilfered. Machinery, stone and lumber are some of the more common things carried on these cars as freight and railroad companies use them almost exclusively for transporting their own material for building and maintaing the roadway such as rails, ties, ballast, etc.

On account of the absence of sides these cars are easy to load and unload, but without any superstructure the strength of the car depends entirely upon the framing and trussing, and it is, therefore, a common practice to make the side sills deeper than the others, and often more than four trussrods are used. There is also a liability of bending the car upward at the center when it is subjected to pushing strains, and it is good practice to put inverted trussrods in the car in addition to the regular ones. On many roads it is the custom, in order to avoid as much as possible the buckling of these cars, to put all flat cars at the rear end of the train, where they will be less damaged on account of their decreased momentum in case of a sudden stoppage of the train.

The material carried on flat cars is usually of such a nature that it will retain its position without any fastening or else it can be held in place by cleats nailed to the floor. Occasionally, howevrr, it is desirable to confine it within some kind of enclosure and flat cars are therefore usually provided with stake pockets, for inserting temporary stakes, to which the freight is tied or nailed or to which temporary sides or ends may be fastened. These stake-pockets are made of cast or malleable iron or pressed

up of steel plate, and are usually fastened to the side sills by means of U bolts passing around the pocket, with the nuts on the inside of the sill; the stakes are usually about 3 by 4 inches at the pocket, tapering down slightly to the top.

The dimensions of most of the flat cars in use approach closely to those of the floor frame which has been shown, viz., about 34 feet over end sills, 8 to 9 feet wide and the floor about 4 feet above the rail. For carrying some certain kinds of freight, however, special cars other than these sizes have been built, and there are flat cars of from 40 to 60 feet long, built specially to carry street cars, and others of large capacity, from 60 to 150,000 pounds, for carrying boilers, coils of cable and other specially large and heavy freight. Very often these large cars are built with a specially low floor and in some cases the draft gear has to be placed between the sills, instead of below them, necessitating a deep end-sill with a hole cut through it for the drawbar, or it has to be placed entirely on top of the floor.

Cars of larger than the usual capacity cannot be carried on the ordinary trucks and they must therefore have special ones or more than the usual number. The axles are sometimes increased in size, so that four of them will carry the weight, but as this makes an odd size of axle, differing from the present M. C. B. standards, it is preferable perhaps to increase the number of axles in each truck, and have them a standard size, and this is done in some cases, trucks being built with three pair of wheels in each. Another construction is to have two standard trucks under each end of the car, connected by an auxiliary frame work resting on the center of each of the two trucks, and the center plate of the car resting on the intermediate frame at its center. Side bearings are provided for both trucks as well as for the intermediate frame.

For transporting long timber logs, bridge trusses and other long material, it is often necessary, in the absence of special long cars, to use more than one flat car, and in loading them provision must be made to allow the cars to pass around curves easily, which is usually done by supporting the material on blocks at its two ends, without touching the floor at any other point, allowing it to oscillate around the points of support without putting any side strains on the drawbars connecting the cars.

When the load extends over from one car to another there is liability of severe accidents, should the coupling between the two cars give away, and it is customary in such cases to take the precaution to pass a heavy chain from the bolster of one to that of the other car, or safety chains are sometimes provided on these cars when considerable long material is regularly carried.

When such long material is loaded on flat cars, it is often necessary to remove the vertical brake shaft at the end of the car, and on roads on which such loads are a common thing, the brake shaft is often arranged to drop out of the way, without removing it from the car, or even disconnecting it from the chain; other roads again have the brake shaft on the side, and on some roads the shaft is done away with entirely, and the brake chain is carried upward around a pulley, and has a ring at its top which is pulled upward to set the brakes and which prevents the chain from dropping down too far when not in use.

On account of not having a superstructure to strengthen the frame, a flat car is perhaps the least adapted to being built longer than the ordinary length of cars, and most of the long flat cars which have been built recently have the frame made of metal. Channel bars and I-beams of either iron of steel are used in some instances for sills and crossties and sometimes also for body bolsters. In other cases the side-sills are made of plate iron, deeper at the center than at the ends, and reinforced by angle irons riveted on.

One of the difficulties experienced with cars with metal sills, is the inconvenience of fastening the floor, which is usually made of wood, a common way being to bolt a piece of timber to the side of the iron sills to which the floor is nailed, which, of course, adds considerable to the weight of the car.

Another construction which does away with the wooden floor, consists of plates of steel, bent in the shape of channels, riveted together so that the flat part of the channels forms the floor, the flanges standing vertically and acting as sills.

As yet, no very large number of metal cars are in use, and even these may be said to be in the experimental stage; further developements in this line are looked forward to with much interest.

GONDOLA CARS.

Gondola cars are used for carrying material which is not injured by exposure to the weather, but which requires an enclosure to hold it, and as more coal perhaps is carried in these cars than any other material they are often called coal cars.

A gondola car can best be described as being a flat car with a box permanently fastened on top of the floor, but without any cover or roof, and usually provided with some means of unloading the material without having to throw it over the top of the box.

The size of the box varies more or less, together with the length and width of the cars, the usual height being from 3 to 4 feet for the floor frame which has been shown. The sides and ends of the box are made of about 3-inch material, white, Norway or yellow pine being used, according to circumstances. The height of the box is made up of several plank, usually from 9 to 12 inches wide, the side plank having keys of cast iron inserted in the joints at several points in their length to give vertical stiffness to the sides. The plank are fastened to stakes set in stake pockets on the side sills and the sides are held down to the floor by strap bolts bolted to the plank, with the ends passing down through the side sills, with nuts on the bottom. The ends of the box are sometimes also supported by stakes and are then fastened to the sides by means of core bands, inside and out, bolted to both sides and ends. The top of the box is protected by straps of flat iron secured by lag screws.

As gondola cars are generally loaded from the top and sometimes also unloaded that way, it is not desirable to have anything passing across the box which might interfere, and it is therefore customary to have the sides depend for their strength only on the stiffness of the material in them, reinforced by the side stakes to which they are fastened, without being connected from side to side other than at the ends. The stakes near the center are sometimes arranged so that two of them are located over the crosstie timbers and extend down to the bottom of these, thereby giving them a longer bearing and making them better able to resist the pressure on the sides. Sometimes, also, the distance between the stakes, near the center, is decreased, for the same object.

Another method of strengthening the sides of gondola cars, which, however, seems to have been abandoned in recently built cars, is that of trussing them, the truss rods passing through the upper planks near their ends, with posts under the rods on the outside of the car, near the center, and nuts bearing on washers against the ends of the box.

The ends of the box on gondola cars are either fixed, as a stationary part of it, or are movable; for the latter purpose the usual method is to have the end plank fastened together to make one door, which is hinged at the bottom, so that it can be dropped down on the floor of the car inside of the box, allowing the load to be passed through the open end thus formed.

Another method is that of having the end arranged in guides on the sides of the car, so that it can be lifted up nearly to the top of the box, stops on the bottom preventing it from being pulled out of the guides. This arrangement is used on some cars in the coal trade in connection with a machine by which the entire car is unloaded through the open end by being elevated at the other end. The box on gondola cars usually does not extend to the outside of the end sills, but stops a foot or so inside of it to provide a foothold for trainmen while using the brakes; steps usually made of flat iron in U shape and handholds on the side of the box are provided for assisting to mount the platform. When the box is over four feet high steps should be provided on the ends to assist the trainmen to reach the top of it.

Gondola cars are generally arranged with doors in the floor, through which material in bulk form can be unloaded, and there are a number of different arrangements of these doors in extensive use. The simplest is perhaps the so-called drop bottom, in

which usually two openings are made in the floor at the center of the car, each extending in width from the center sill to the outside intermediate sill, the length being limited by two headers placed across this opening about 5 feet apart, these headers being mortised to take the ends of the short inside intermediate sills when these are used. The bottoms of the sills and headers are in one plane, and the doors when closed are held up against the opening thus formed. These doors are double, and each is made of two or three planks held together by straps of iron, which terminate in an eye forming part of a hinge, the other part, usually two eyebolts or straps of iron ending in eyes, being fastened to the headers.

The plank usually extends across both openings in the floor, a narrow piece of flooring being placed over the center sills and the space between them, forming a convenient place for trainmen to pass over on when the car is empty. The drop doors are occasionally placed so as to open longitudinally with the car instead of transversely. The doors are held in place and also drawn up into place by means of chains, fastened to them by eye-bolts, the other ends being secured to a shaft of round iron passing across the car at its center and resting on cast-iron pieces placed on the floor. This shaft terminates at one end in a square, over which is placed a ratchet wheel, the square projecting far enough through this to enable it to be turned by means of a wrench. A pawl, engaging the ratchet wheel made usually of a bar of square iron hung at one end and a dog of eccentric shape for holding the pawl in place when the doors are up, are also provided and are generally fastened to a plate of iron on the side of the box; the other end of the winding shaft projects through the side of the box, and holds a pin and washer to prevent the shaft from moving endwise.

Although winding shafts like that described have used almost exclusively for dropdoors ever since these have been in existence, there are quite a number of objections to them, one of the principal ones being that the shaft becomes bent by pieces of material striking them when the car is being loaded, which makes them work hard and wind the chains up unevenly; another objection is that the chain will sometimes wind up on itself, also causing uneven raising of the doors; and another is that the chains are very liable to break, dumping the load upon the road: this latter trouble is sometimes also caused by the pawl on the ratchet wheel becoming disengaged. A number of designs have been introduced whose object is to do away with some of the objections mentioned, and a few of these will be described.

One of the earlier methods to do away with the chain is that of holding the doors up by means of a rod terminating at its bottom end in a tee which when placed across the opening between the doors will hold them up, but when turned one-quarter way around it allows them to drop; the doors have to be raised to their place by lifting them up from the bottom. This is one objection to this device, and another is that a piece of timber has to be placed across the box at the top to hold the upper end of the rod, which is provided with a means of locking it in place and terminates in a square for a wrench to turn it.

Several other devices have a chain and shaft for raising the the doors, but the shaft is not exposed where material can drop on it and is provided with worm wheels for the chain, which prevents the latter from winding on itself; the doors, when in place, are held up independently of the chains by means of latches which are forced out by springs or weighted levers, and which are drawn back, when the doors are to be dropped by means of cams or levers attached to another shaft. A wheel is sometimes attached to the winding shaft and the ratchet and pawl are omitted, in order to prevent the doors from being partly closed and left in that position. An innovation which has been introduced in connection with the device just mentioned is that of having the dropdoors close flush with the top of the floor, doing away with the pockets which would remain full of the material with which car is loaded, when being unloaded through the end by being inclined, as has been referred to.

Other designs use a combination of rods and levers to raise the doors and hold them in place, which, while doing away with chains, introduce other objectionable features, and it might be said that as yet no entirely satisfactory method has been devised for raising and holding up the dropdoors of gondola cars.

While dropdoors in the floor afford a means of unloading cars through the bottom, there is, nevertheless, considerable labor attached to this performance, as but little of the load will run out of the door openings and all that which does not lie immediately at these opening must be brought there by artificial means. To overcome this point, the bottoms of gondola cars are sometimes made to incline toward the door openings, the amount of the slope being dependent on the height of the box, the depth of hopper permissible, and on other details of the car. A car on which the entire bottom slopes does not answer very well to load anything but material in bulk from, and the bottom of hopper cars is, therefore, often made so that only part of it slopes, the ends of the floor being left as in other cars, on which material can be placed and long material can be loaded to cover the entire hopper. This, however, introduces the objection again of having to use a shovel to some extent to unload the car. On roads, however, which have an extensive trade in bulk material, such as coal, where the labor saved in unloading offsets the loss incurred in hauling the empty car back to be re-loaded, it is becoming the practice now to build gondola cars with the entire floor on a slope, which allows all the lading to run out of the door openings without any manual assistance other than opening the doors.

In order to get sufficient slope to the hopper, it is necessary to extend it below the line of the sills, and the center sills are usually carried through the hoppers, being covered over by short pieces of flooring; this space included by the center sills often serves to carry the brake connection from one end of the car to the other.

Hoppers usually also slope slightly at the sides, in order to reduce the width of the doors to the space between the rails; to get as great a slope as possible on the ends, two openings are sometimes provided, separated as far as the trucks will allow, and the part between them is also made to slope from the center of the car each way to the openings.

The dropdoors of most hopper cars close in a horizontal position, but recently some have been built in which the doors, when closed, stand at about a right angle with the slope of the hopper, thus making a slight angle to the vertical: they are hinged at the top and are worked by means of rods and levers, forming a toggle joint.

To unload gondola cars through the dropdoors, they must be placed on elevated trestles having openings between the rails through which the load can fall. This is not always desirable or possible, and there are other cases where it is desirable to have the load dumped on the ground on the side of the car. For this purpose side dump-cars have been devised. These consist of a box similar to that of the gondola car, but the lower part of the sides is movable and is hinged to the upper part, and is divided into a number of parts or doors, which when closed slope toward the car, and when released fall to a vertical position. The floor is elevated at the longitudinal center, and slopes down to meet the bottom of the doors. The latter are held in place, when closed, by chains winding on worm-wheels on a square shaft running through the center of the car, the other end of the chain being fastened to a link which connects it to the door, these links working in slots in partitions which divide the length of the car into as many spaces as there are doors. The shaft is turned by means of a ratchet-wheel on the end, situated over the platform formed by the projecting end sill, a pawl attached to a lever being used to turn the wheel.

A number of ore-cars are used on several roads, built similarly to the last-described cars, having a capacity of 80,000 pounds, using three trucks, the middle one being placed at the center of the car without any center-plate or pin, the body of the car resting on rollers which allow the necessary adjustment on curves, the two end tracks being arranged with center-plates in the usual manner.

(To be Continued.)

Notes by the Way.

The present depressed condition of railroad business makes the gathering of notes and information a difficult and a somewhat depressing task. For this reason it is to be feared that rather a somber tone will pervade the report of a recent hasty journey which was made from the Metropolis to St. Louis. Other interests and not those which usually induce an editor to travel led to the journey, so no special effort was made to collect information, other than that of merely calling on railroad officers in a very casual way, and thus consuming some of their valuable time in what may be called professional gossip, relating to what they are doing and expect to undertake.

In Baltimore, Mr. Harvey Middleton, the General Superintendent of Motive Power of the Baltimore & Ohio Railroad, had just returned from making a test of one of his new ten-wheeled passenger engines, which was very satisfactory, and he then felt assured that they were an undoubted success. Having been absent for some time, there was not much opportunity for talk or gossip. His frame of mind was, however, somewhat more cheerful than that of most railroad men at this time, which was perhaps partly due to the fact that the Baltimore & Ohio being in the hands of a receiver, imposes no responsibility on its employees to pay dividends, and many other obligations may be staved off to what may be called a future by and by. Various improvements are contemplated, among them a new erecting shop at Mount Clair shops in Baltimore, with longitudinal tracks and travelling cranes of the most modern design and plan. A large order for freight cars is pending and the management is hopeful of improvement in business and renewal of prosperity. May they not be disappointed, will be the ejaculation of all who hear of it, especially the stockholders.

From Baltimore to Altoona is but a few steps—that is, you step into the car at the one place, and in a few hours out of it at the other, and that is about all the labor of the journey. At Altoona, increased and continued efforts are made to economize and reduce expenses. Reports of businees were unfavorable, men in the shops are working short time, and little new work is in progress, and the universal question was "When will things be better?"

In brief interviews with Mr. Casanave, Mr. Atterbury, who has succeeded Mr. Wallis as Superintendent of Motive Power at Altoona, Doctor Dudley, Chemist, and T. R. Browne, Master Mechanic in charge of the Juniata shops, the slackness of business and need of economy was reiterated. At Juniata we acquired some interesting information about Mr. Browne's oil furnaces, which will be given in full this month. Dr. Dudley was then interested in the disinfection of passenger cars, a subject which has been taken up by the United States Marine Hospital service in Washington. A new disinfectant, known as "formalin," is being experimented with which promise excellent results. Experiments have shown what might have been expected, that the dirt which accumulates in cars is very prolific in disease germs, and the microscope makes it seem possible to catch almost any disease in a car. The new disinfectant vaporizes at low temperatures, and if confined inside of a car, permeates every crevice and into the texture of the material, if it be at all porous, and it is said to be the most destructive agent of microbes and other infinitely little beasts, which has yet been discovered. It is certainly a subject of very great importance and worthy of the most thorough investigation.

At the Pittsburgh Locomotive Works they have a splendid plant, with little to do. These works have been remodeled and to a great extent rebuilt within a comparatively few years, and it is now one of the most complete locomotive shops in the country, with facilities for building a large number of engines per year. Mr. H. K. Porter, of the locomotive works bearing his name, reported that they were giving a great deal of attention to compressed air locomotives, and have recently been making some new experiments in reheating the air with excellent results. Much time, money and ingenuity have lately been expended in this direction.

From Pittsburgh a night journey takes a traveler to Indianapolis, which, at the time it was visited, was drenched with rain. It is headquarters of the machinery department of the Cleveland, Cincinnati, Chicago & St. Louis Railroad, over which Mr. Garstang presides. He is well housed in comfortable offices, and administers the affairs of his department which now covers 2,290 miles and 548 locomotives. Like many other heads of machinery departments he has had more or less trouble from the breakage of car and locomotive axles, which has led to the examination of many specimens by etching sections of them with acid. He has collected numerous interesting etchings, which show many degrees of goodness and badness. It is a somewhat fantastic belief of Swedenborgians that every transgressor leaves its record in the human body, and that after death each person's body will be taken possession of by angels, who will examine it from the soles of the feet to the crown of the head, and will determine therefrom what his life and conduct have been. There is some anology between the etching process here referred to and the doctrine described, the action of the acid shows very plainly the character of the original material from which an axle was made, and also how it was worked during the process of manufacture, the purity and the impurity of the material used and reveals its original nature and many of its defects. The process may therefore be regarded as a sort of mechanical Swedenborgianism. If it produces as good results in its application as the religious faith referred to does in some of its believers it would be an incontrovertible reason for its adoption.

The shops of the C. C. C. & St. L. road are some miles out from Indianapolis and there was not time to visit them. The local shops of the Pittsburgh, Cincinnati, Chicago & St. Louis, are, however, in Indianapolis, and are presided over by Mr. Swanson. These shops are said to be the most idyllic of any in the country. They were built among a grove of forest trees, and those in charge had the good sense and good taste to leave the trees standing and lay out the grounds among them in paths and walks, so that the buildings are now located in a small park. Little is done here excepting repair work, and at present not very much of that.

St. Louis was smoky as of old. It is interesting to take some of the many cable and electric car lines, and ride from the center of the city to the end of the lines. The city, it need hardly be said, is located on the western bank of the Mississippi, and it has the whole of the eastern portion of the State of Missouri to grow into. Lines of electric and cable roads have been built from its center, radially, and extending in many different directions. It may be stated as a general proposition, that the available area into which a city can grow is increased with the square of the speed of the means of transportation. The increased speed of electric and cable cars has thus opened up a very large territory, which has been partially occupied by the population, and has made suburban and semi-suburban residence practicable for many who could not live in such localities, if they had to depend upon the slower means of transportation, which aforetime was provided in this city by the patient mule. Detached houses, with a liberal amount of ground around them, are frequent, and in the newer parts of the city there is no overcrowding, and there is still much unoccupied ground.

A stranger is struck with the size of many of the cars on the electric roads. Many of them have eight wheels and are carried on two trucks, and are nearly or quite as large as the cars on the New York Elevated Railroad. Others have six wheels, with an arrangement which permits the axles to assume radial positions in relation to curves. On the cable lines a closed four-wheeled car is run behind an open motor or "grip" car. The incessant clanging of the bells, and the agility required to avoid being run over, does not add to the sense of security one has in the streets.

The only railroad shops of any considerable size or note in St. Louis are those of the Missouri Pacific Railroad. Mr. F. Reardon is Superintendent of the Locomotive and Car departments, and Mr. L. Bartlett is Master Mechanic.

One of the noteworthy features of these shops is the general use of compressed air for various purposes. In the machine shop we were shown an arrangement which commended itself. It was in the department where the connecting and coupling rod work is done. Over this and attached to the ceiling is a circular track almost 25 feet in diameter with a radial arm pivoted at one end at the center of the track, and the other end running on a trolley on the circular rail. The arm also has a trolley running on it radially to the track, which carries an air hoist, which is suspended therefrom. Of course, any point under the circular track can be reached by this appliance, and there is no obstruction of the floor or space over it.

Quite a number of small three-cylinder engines, of the Brotherhood type, have been built in these shops, and are mounted on three-wheeled trucks, which can be moved anywhere to do work which cannot conveniently be brought to a machine. This work includes the boring of cylinders, facing-off valves, drilling of various kinds, etc., etc. These engines have been found to be very convenient, and have been supplied to most of the shops on the line of the road.

Another device is a pneumatic ash-hoist. This consists of a track which is elevated about 2½ feet above the ground, and is supported on cast-iron stands or columns placed about 7 feet apart, on the top of which inverted rails are placed, and the running rails on top of these, but not inverted. This brings the bases of the two rails together. The object of this is to secure sufficient strength to carry the loads on the rails, which rest on supports 7 feet apart. Square receptacles or buckets about 18 inches deep are made to go between the rails and their supports, and as the latter are elevated the buckets are below the track. When an engine is to be de-ashed, it is run on the track and over a series of the buckets, into which the ashes are raked. When this is effected the engine is backed off of the track, and at the same time draws a portable crane which is mounted on a four-wheeled car on the track into a position in which it can take hold of the buckets and swing them over and dump the ashes into cars on an adjoining track. The crane is operated by compressed air both for hoisting and swinging it. The air is supplied by the brake pump of the locomotive. Of course, the track might be laid on the surface of the ground, and pits could be excavated to receive the buckets.

Another device, which it is also said saves a great deal of time and labor, is an arrangement for removing spring hangers, but this could not be explained without engravings.

They are also making what, to the writer, was a novelty in tanks for locomotive tenders. The sides and end of the coal-pit of the tank, instead of being made vertical, are made with a considerable inclination, so as to approximate to a hopper form. This carries the coal forward, so that little or no handling is required by the firemen.

The practice of burnishing the journal bearings of axles is also much used in these shops. This is done with a steel roller, similar to that which was described and illustrated in connection with the Altoona shops in our issue for January. As the roller moves along the surface of the journal it leaves a distinct ridge between the portion which is compressed and that which is not, which can be readily felt by touching it with a finger. Very excellent results are obtained from the more satisfactory wear of journals which have been burnished compared with those which have not been so treated.

One of the complaints which is heard in the Pacific shops, and which will doubtless be reiterated a great many times hereafter, is the lack of firebox capacity in modern engines. Western coal is inferior to that which is used in the Eastern States, and the size of engines has grown, but the width of their fireboxes has not. The result is that the bellies of iron horses are not big enough for the work they have to do. There is a distinct demand growing up for a design of engine with larger fireboxes and this demand will become more urgent if the size of our engines should be increased still more.

A Two-Hundred Foot Gantry Crane.*

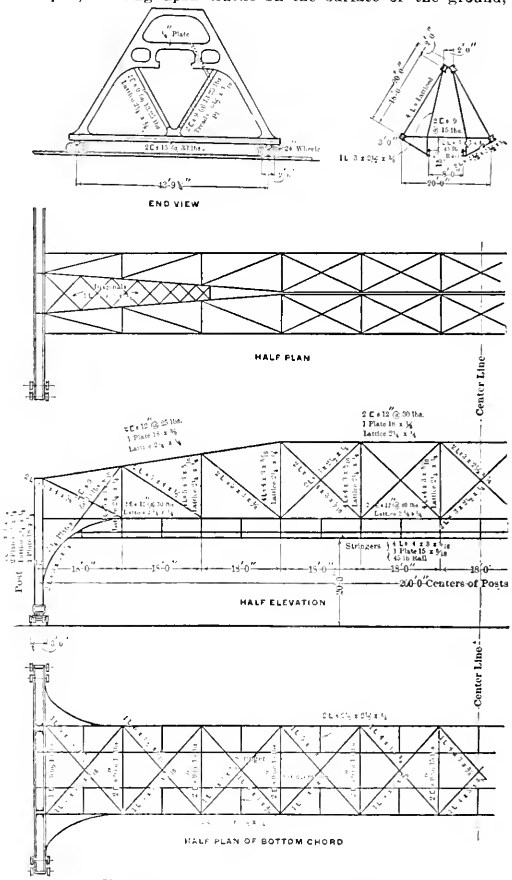
BY JOHN W. SEAVER, CLEVELAND, O.

In the latter part of the year 1895 the Cambria Iron Company, of Johnstown, Pa., decided to construct a storage and loading yard for their proposed new structural mill at Johnstown, Pa., and invited several engineering firms to submit estimates and designs for a plant to handle the material that it was intended to store and load in this yard.

Among the firms invited to submit proposals, that with which the writer is connected took up the matter at once, and gave it a great deal of very careful study. The yard it was designed to cover—400 by 800 feet—was so large that it was evident from the beginning that unless some very economical form of construction should be proposed, the expense of covering the area would be very great. There are several methods by which the desired object can be attained, and each plan was carefully considered and its objections and advantages compared.

The various systems of swinging cranes, locomotive cranes and overhead traveling cranes were all considered, but their cost and the yard space they occupied, and other objections, were deemed sufficient to cause their rejection in favor of the Gantry crane system.

This plan contemplates the use of two traveling cranes, each 200 feet span, running upon tracks on the surface of the ground,



Trusses for a 200-foot Gantry Crane.

parallel to the length of the yard, so that the two cranes cover the whole surface, with the exception of three spaces, one 5 feet wide down each outside edge of the yard, and one 10 feet wide down the center. There is one line of track down each outside edge, and two lines of track down the center.

It was proposed to mount the cranes upon end frames or legs, making them what are commonly called "Gantry cranes," and to make the legs or end supports of sufficient height to allow a train of cars, with men on top of same, to pass freely underneath. For this purpose the clear height from the top of the rail to the un-

* From a paper presented at the New York meeting (December, 1896,) of the American Society of Mechanical Engineers.

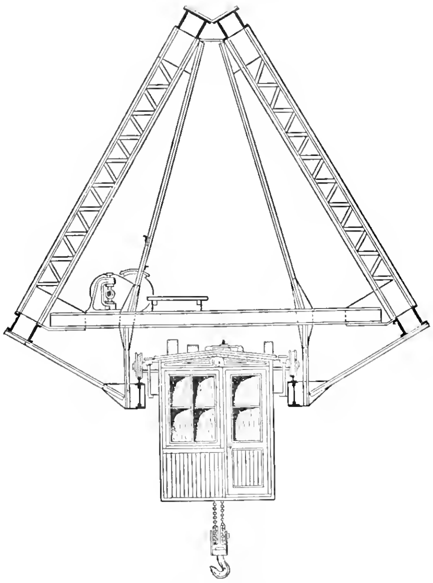
derside of the stringer that the crane trolley traverses, was fixed at 20 feet; and as the height from the surface of the yard to the top of the rail is 14½ inches, a clear height from the surface of the ground to the underside of the crane of 21 feet 2½ inches is obtained.

The magnitude of these proposed Gantries caused the matter to be most carefully considered, both by the Cambria Iron Company and the Wellman Seaver Engineering Company, who submitted this plan to them for their consideration. After a thorough examination of the plan proposed by them they were awarded the contract.

The firm decided upon a form of construction that they believe to be entirely original. It consists of two main girders of the Pratt type, with vertical posts and diagonal tension braces, the bottom chord being straight and the top chord parallel to the bottom chord for about one-half its length, and then inclining to the end posts at such an angle that the depth of truss at the ends is one-half that at the center. These two main trusses are framed together at an angle of 60 degrees. The top chords have their parallel portions connected with splice and tie plates. The bottom chords are parallel to each other and separated a distance of 20 feet. The main trusses are 18 feet deep at center and 9 feet deep at the ends. This peculiar form of construction gives the arrangement of the main tresses the appearance of a steep hipped-roof, very long in proportion to its height. A cross-section at the center is that of an equilateral triangle, and the cross-section of any point between the end posts and where the top chords join each other is that of a trapezoid.

Suspended beneath the bracing that separates the bottom chords is a runway for the crane trolley to travel on. This runway consists of riveted I-beams, with T-rails secured to their upper flanges. The stringers are very rigidly braced to the chords of the main trusses, not only at the panel points, where they were suspended, but also at the middle of each panel.

The horizontal bracing between the trusses consists of a series of floor-beams, firmly riveted to the posts of the trusses, and forming the struts of the lateral system. The diagonal members consist

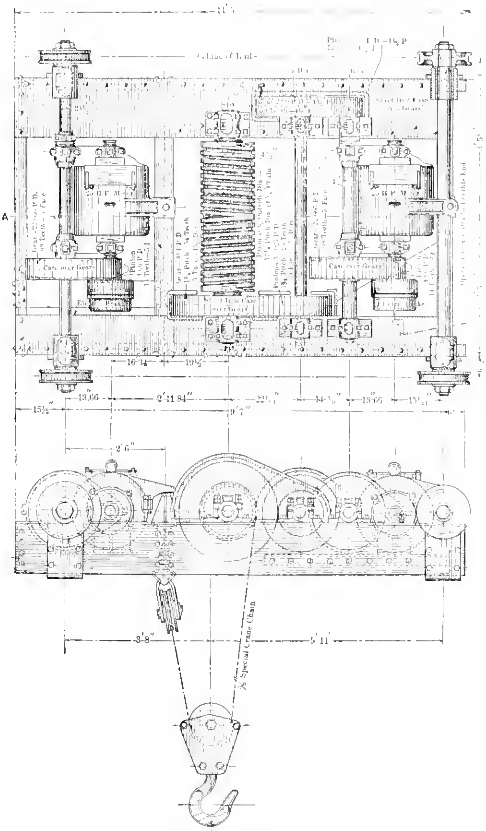


Section of Truss.—200-foot Gantry Crane.

of angle irons riveted to wing plates secured to the trusses and floor-beams, these wing plates being bent to conform to the angles of the floor system and the trusses. To prevent any cross strains of the struts resulting from the live load (the weight of the stringers and trolley), it is taken directly from the stringer suspenders up to the top of the posts of the main trusses by means of diagonal suspender angles.

Resting on top of the floor beams are two lines of channel irons parallel to the main trusses. These channel irons form stringers for the foot walk, which extends the full length of the crane. The floor beams also carry the pillow-blocks for the main shafting. At the ends of the crane, and in the plane of the trusses, are carried down riveted legs, or supports of the box form. These legs are firmly braced to the bottom chords of the main trusses, with large plate iron brackets, well stiffened with angle iron flanges. The legs are also braced to each other crosswise of the crane, with a system of horizontal and diagonal braces, with a stiff tie-beam at the foot of the legs.

The width from center to center of the trucks supporting the crane is 43 feet 9¾ inches, forming a wheel base for the crane of a little more than one-fifth of the span, which is sufficient to square the crane on the tracks.



Trolley for 200-foot Gantry Crane.

The top chords are made of two channel irons with a cover plate on top, and latticing on the bottom. The bottom chords are made of two channel irons, latticed on top and bottom, so as to afford no room for lodgment of moisture; this point being carefully kept in view throughout the construction.

The vertical posts of the trusses each consist of four angle irons latticed together. The diagonal members of the trusses are each formed of two angle irons riveted at their intersection.

The loads and strains adopted for this crane were as follows: A live load for trolley equal to 20,000 pounds. To this was added, for impact, 25 per cent., or 5,000 pounds. The weight of the trolley was estimated at 23,000 pounds, making a total of 48,000 pounds distributed on four wheels, spaced about 9 feet centers, bringing a reaction upon each stringer support of 18,000 pounds.

To still further provide for any sudden application of a live load, it was assumed to be equal to 22,000 pounds applied at any panel point of bottom chord of each truss.

This is largely in excess of any load that will come upon the crane; but it was considered advisable to use it, in view of the fact that the load might catch, thereby bringing a greatly increased weight upon the trolley.

The dead load, weight of trusses and floor, was assumed at 88,000 pounds per truss, or 8,000 at every point of bottom chord of each truss.

In order to provide for a very large factor of safety in the bottom lateral system, a wind pressure of 20 pounds per square foot was assumed, or a load of 5,000 pounds at each panel point of bottom chord. To resist these combined loads, the following limitations of strains were adopted:

For live loads.	Tension	12,000	lbs. per sq. in. of net section.
	Shear	6,000	" " " " " "
	Compression	10,000	" of gross section.
Bearing on rivets and bolts		12,000	" per sq. in.
For dead load.	Tension	15,000	" " " " of net section.
	Shearing	10,000	" " " " " " "
	Compression	12,000	" " " " " gross section.
Bearings on rivets and bolts		15,000	" " " "

All of these strains are largely in excess of what the writer would recommend for an ordinary crane construction; but the ratio of dead load to live load is so great that it was necessary to observe the greatest possible economy of material to avoid the crane being so heavy that it would be impracticable.

The minimum speeds of the various motions of the crane are as follows:

Traverse of main bridge	200 feet per minute.
" trolley	400 " "
Hoist with full load	20 " "

The crane rests upon four trucks, each having four steel-tired double flange wheels, 24 inches in diameter. The wheels are keyed to steel axles, 5 inches in diameter. The gage of the track is 3 feet 6 inches centers of rails. The journals are 5 inches in diameter, 7 inches long, fitted with bronze bearings carried in cast-steel oil-boxes, with ample provision for lubrication. The wheels on one truck at each end are connected by means of a system of shafts and beveled gear-wheels. The gear-wheels are steel castings and are of extra heavy design throughout. The shafting from one truck to the other is four inches in diameter. The couplings are all rigid flanged couplings, tightly keyed to the shafts, and fitted with turned bolts of a tight driving fit. The main shaft, extending the length of the crane, is carried in universal bearing pillow-blocks of very heavy design. These pillow-blocks are bolted to the cross beams of the floor system, with packing pieces between them and the beams, and are lined up perfectly true and level. The end bearings, where the main shaft is geared to the diagonal shafts that connect it to the trucks at each end, are carried by compound boxes, so that it is impossible for the main and angular shafts to get out of line.

The top of each truck carries a steel socket or cup and in this socket is placed a hard steel ball 6 inches in diameter.

The bottom of the end supports are also provided with corresponding cupped sockets. The ball rests in a slightly elongated groove; the major diameter of the groove being crosswise to the center line of the truck, and the minor diameter being parallel to the track on which the truck rests. By means of this elongation of the groove, the ball is allowed a slight motion at right angles to the center line of the track on which the truck travels, and this permits of the expansion and contraction of the main girders of the crane. It also allows the trucks upon which the crane travels to be slightly out of alignment, as the balls form universal joints between the trucks and the crane.

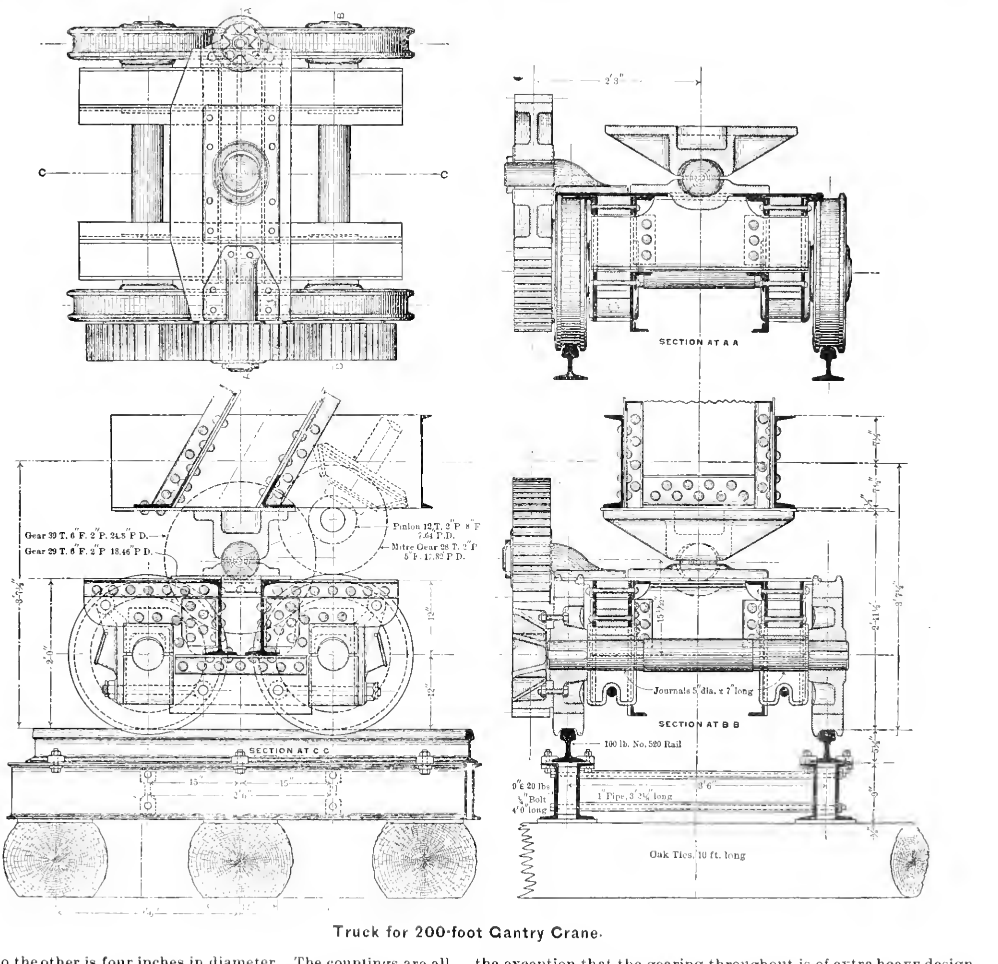
The arrangement of the gearing connecting the driving shafts to the trucks is such that the vibrations of the trucks around the centers of the balls do not disturb the alignment of the gearing to an appreciable amount as the centers of the main driving spur wheels are on the same lines as the centers of the balls.

In the center of the crane is placed a 50-horse-power electric motor, connected directly to the main shaft with one reduction of steel gearing. The trolley which travels upon the suspended run-away beneath the main chord is of the ordinary crane type, with the exception that the gearing throughout is of extra heavy design, and of either steel or bronze castings. The winding-drum is of cast iron, with right and left hand grooves for the chain, milled out of solid metal. The traversing of the trolley upon the track and the hoisting is done by two 25 horse-power electric motors. All the motors are wound for 220 volts.

The operator's cage is attached to and moves with the trolley. It is provided with windows on all sides, so that the operator can have a clear view of any part of the yard. In the cage are placed the controllers which govern all the motions of the crane, and the necessary switches, cut-outs, etc.

Attached to each truck are two snow-plows, or guards, made of plate stiffened with angle irons. These snow-plows are easily removable, so that access can be had to any part of the trucks.

The end frames are so arranged that should it be desired to transfer a load from one side of the yard to the other, both cranes can be brought in line with each other by means of removable stops on the trucks, and the trolley from either crane run directly through the end supports and on to the track on the other crane.



Truck for 200-foot Gantry Crane.

Evaporative Trials of an Almy Water Tube Boiler.

In these days when the economy of water tube boilers is called in question so vigorously by their opponents, the following report of a test made in November by Geo. H. Barnes, of Boston, on an Almy boiler in the shops of the Almy Water Tube Boiler Company, Providence, R. I., will be of interest. The boiler is one which has been in use about fifteen months, supplying steam for the engine and other purposes required in the shop. It was not cleaned or in any way specially prepared for a test, except as noted further on. From the report we condense the description of the boiler and the method of making the tests, but we give the results in full.

The boiler is of the size marked in the catalogue, Class D., in which the dimensions of the outside casing are: length, 51⅝ inches; breadth, 51⅝ inches, and height to top of casing, 78 inches. The grate is 40.1 inches long and 40.9 inches wide; and the area of the surface is 11.38 square feet. The bars of which the grate is composed are $\frac{9}{16}$ of an inch wide and separated by $\frac{5}{32}$-inch air spaces. The number of one-inch pipes (two pipes to a section) which make up the length of the boiler, is 26, and the total exterior heating surface, without allowance for portions more or less covered and unexposed to direct heat, is approximately 474 square feet. The area of opening for draft between the tubes is 4.6 square feet. On the morning of November 2d, previous to the test of that date, it was reduced by the introduction of fire brick to one-half this area, or ⅕ of the area of the grate surface. The estimated weight of iron in the boiler, not including the covering, is 3,097 pounds, and the weight of contained water at the ordinary level, 650 pounds. The stack is 19 inches in diameter, and its height above the grate is 35 feet 6 inches. The covering consists of wrought iron plates put together with angle irons, and lined with layers of asbestos and fire brick. The outside of the iron surface is unprotected. Prior to the tests, all the cracks and crevices in the covering, due to loosely fitted doors or joints, were scaled up with cement. The firedoor contains eight holes, ¾ inch in diameter. The boiler is fed by means of a steam pump supplied with cold water. The water receives no heat on its way to the boiler, save that which comes from the coil of pipe, termed the "heater," located in the very upper part of the boiler chamber next to the stack. The steam used by the shop engine, and that required for other purposes, is less than the working capacity of the boiler, and in order to provide for suitable conditions for the evaporative tests, the surplus steam not required for the ordinary work of the shop was allowed to escape through the safety valve to the atmosphere. During the progress of the tests there was a continual discharge of steam at this point.

On the two runs with forced draft, the tests were commenced and finished under running conditions, and the condition and thickness of the fire at beginning and end were estimated. It should be stated here that these trials are of too short duration for absolute reliabilty as to the coal measurements. They were intended mainly to show the capacity of the boiler in horse-power under the conditions of forced draft.

The feed-water measurements, steam pressures, temperatures, quality of steam, force of draft, etc., were all determined with great care.

Samples were taken of the flue gases. On the run of Oct. 31 a sufficient number of analyses were made to secure a fair average for the entire test. On the tests of Nov. 2 the analyses were confined to a short period in each case.

The coal was sampled on each run and dried for determining moisture. On the two main trials, that is, Oct. 31, and the economy test of Nov. 2, the samples have been subjected to a heat test in the writer's coal calorimeter, and that of Oct. 31 has, in addition, been analyzed. With the data obtained from the heat test the coal analysis and the gas analysis, a complete heat balance has been drawn up for the test of Oct. 31, as appears in the tables of results. The gas analysis of Nov. 2 did not cover a sufficient period to enable the heat balance to be worked out.

At the close of the test of Oct. 31 a radiation test was made which gave a result equal to 46,477 British thermal units per hour.

The coal used on all the tests was of the same grade and class, viz., George's Creek Cumberland, obtained from R. B. Little & Company, in Providence. It was in commercially dry condition and it was fired without further wetting. On Nov. 2 the system of firing was the ordinary spreading system, the bed of coal being maintained at a thickness of 3 or 4 inches.

On a preliminary run on Oct. 30 a greater thickness of fire was maintained than that noted above, and the results of the gas analysis showed the presence of a comparatively larger amount of carbonic oxide, sometimes reaching as high a percentage of the total volume of gas as 16.9 per cent. It is interesting to note this fact, for the reason that the thickness of the fire was by no means excessive, seldom reaching more than 8 inches for the entire depth. The evaporative result obtained on this run conforms to what would be anticipated from the gas analysis, being only three-quarters of that obtained on the main tests reported in the table.

The data and results of the tests are given in the accompanying tables, of which Table No. 1 relates to the general data and results and Table No. 2 to the heat balance of Oct. 31.

TABLE No. 1.

DATA AND RESULTS OF EVAPORATIVE TESTS ON ALMY WATER TUBE BOILER AT PROVIDENCE, R. I.

Grate surface, 11.38 square feet ; Heating surface, 474 square feet.

Kind of coal—George's Creek Cumberland.

Per cent. of moisture in coal	2.4	1.8	1.8	1.8
Conditions as to capacity	Normal.	Normal.	Forced draft, 1 heavy, 2 m'dium.	
Date of test—1896	Oct. 31.	Nov. 2.	Nov. 2.	Nov. 2.
TOTAL QUANTITIES.				
1. Duration— hours	9.15	6.1	.03	2.0
2. Weight of dry coal consumed, lbs	1,274.	971.	831.	543.
3. Weight of ashes and clinkers, lbs.	110.	100.	...	...
4. Per cent. of ashes and clinkers, per cent	8. 6	10.3	...	...
5 Weight of water evaporated	11,332.	8,610.	6,560.	4,414.
HOURLY QUANTITIES.				
6. Coal consumed per hour, lbs	139.2	159.2	409.4	271.5
7. Coal consumed per hour, per square foot of grate, lbs	12.2	13. 99	35.98	23.86
8. Water evaporated per hour, lbs	1,238.5	1,403.6	3,231.	2,207.
9. Equivalent evaporation per hour, feed 100 degrees, pressure 70 lbs., lbs	1,300.4	1,472.8	3,389.3	2,315.1
10. Horse power developed on basis of 30 lbs., H. P	43 3	49.1	112.98	77.2
11. Equivalent evaporation per sq. ft. heating surface per hour, lbs.	2·74	3.1	7.15	4.88
AVERAGES OF OBSERVATIONS.				
12. Average boiler pressure, lbs	117.1	146.8	153.6	110.1
13. Average temperature of feed water, degrees	56.7	56.6	56.	56.
14. Average temperature of flue gases, degrees	513.	473.	850.*	715.*
15. Average draft suction, inches	.12	.11	.71	.4
16. Per cent. of moisture in steam	0.35	0.4	0.72	0.42
17. Weather and outside temperature	Clear warm.	Clear mod'rate	...	...
18. Total heat of combustion per pound of dry coal, B. T. U	...	11,168.	...	...
19. Total heat of combustion per pound combustible, B. T. U	**	15,186.	...	...
RESULTS.				
20. Water evaporated per pound of coal, lbs	8.895	8.867	7.894	8.129
21. Equivalent evaporation per pound of coal from and at 212 deg., lbs.	10.736	10.694	...	...
22. Equivalent evaporation per pound combustion from and at 212 degrees, lbs	11.746	11.922	...	...
23. Efficiency on combustible, per cent	...	75.8	...	...

*Only one observation. The actual temperature on the heavy forced draf test was higher than 850 degrees, the limit of the thermometer used—probably 900 degrees.
** See Table No. 2 for heat of combustion, computed from analysis.

TABLE No. 2 (a).

RESULTS OF GAS ANALYSIS GIVEN IN PETCENTAGES BY VOLUME.

Date, etc.	Oct. 31. Averages for whole test.	Nov. 2. One hour of main test.	No. 2, forced draft tests. 1.	2.
Carbonic acid, CO_2	13.1	10.7	13.4	12.0
Carbonic oxide, CO	0.9	2.8	1.9	0 7
Oxygen, O	4.8	5.4	3.1	5.8
Nitrogen, N	81.2	81 1	81 6	81.5
	100.0	100.0	100.0	100.0

TABLE No. 2 (b).

DATA FOR HEAT BALANCE.

Carbon in combustible	87.	per cent.
Hydrogon in combustible	4.7	"
Carbonic oxide in combustible	$\frac{.9}{13.1 + .9} \times 87. = 5.6$	"
Hot gas, not including moisture, per pound of carbon	17.95	pounds.
Hot gas, not including moisture, per pound of combustible	15.62	"
Temperature of gases above air	513 — 72 = 441.	degrees.
Heat in one pound of moisture in the gases	1251.	B. T. U

TABLE No. 2 (a).

HEAT BALANCE.

Total heat of combustion calculated from analysis, per pound of combustible (carbon, 82.6 per cent.; hydrogen, 4.5 per cent.; ash, 5.1 per cent.; oxygen, 4.8 per cent.; nitrogen and sulphur, 3 per cent.) 15,169

	B. T. U.	Per cent.
1. Heat absorbed in useful evaporation—11.74 × 966 = ..	11,347	74.8
2. Heat lost in hot gas—15.62 × 441 × .238 = ...	1,639	10.8
3. Heat lost by sensible and latent heat of moisture in coal and moisture formed by burning hydrogen—(.047 × 9 + .024) × 1251 = ...	562	3.6
4. Heat of combustion lost by unconsumed CO, .056 × 10,050 = ...	503	3.2
5. Radiation as per test.....	365	2.4
6. Loss from carbon in smoke, hydro-carbons in same and unaccounted for.	753	5.2
	15,169	

The report concludes with the following statement:

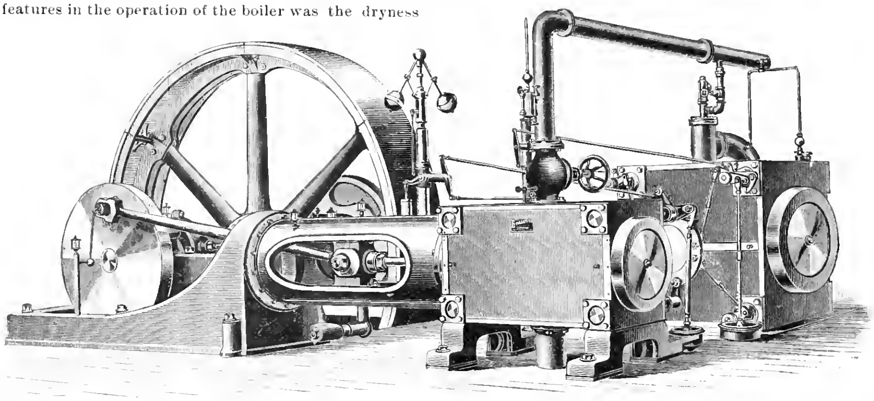
It appears from these results that, in point of economy, the boiler compares favorably with the best types. An evaporation of 11.922 pounds of water per pound of combustible, which was obtained on the test of November 2, is rarely exceeded by any form of hand-fired water tube boiler, whatever its size. One of the noticeable features in the operation of the boiler was the dryness of the steam exhibited on all the tests. Even with conditions of forced blast, when over seven pounds of water was evaporated per square foot of surface per hour, the moisture was less than one per cent. The heat balance given in Table No. 2 shows that practically all of the heat units available in the coal were accounted for, either in useful evaporation, or in chimney and other wastes.

English papers state that the French Ministry of Marine finds itself in the strange position of being unable to spend as much money as the nation wishes them to. The French nation is anxious to maintain her position as a first-rate naval power. To do so it is necessary that ships be built during the present year to the value of about five millions sterling by France, which when exerting herself to the utmost, is apparently unable to spend more than about £4,000,000 per annum on the building of new vessels, because of the slow pace at which work progresses in her ship yards. The *Engineer* says: "It is clear that other nations who either provide for themselves or purchase from others will rapidly go ahead, and France will gradually sink into the position of a secondary maritime power. There is, however, a way of escape left to the French nation. It, too, may purchase its ships abroad, and to what country can it go with more certainty of having its orders despatched with punctuality and conscientiousness than perfidious Albion?" The *American Engineer* would suggest that American ship yards can help the French nation to build its ships, and thus enable it to spend money in establishments that do not belong to its antagonists, England and Germany.

Cross-Compound "1890" Engine, Built by the Edward P. Allis Company.

The engines of various types built by the E. P. Allis Company of Milwaukee, Wis., are favorably known in every part of the world where steam power is generated and used. It has always been the policy of this company to make every engine sold a complete success from an engineering and commercial standpoint, and to this end it has employed the best of talent. This, added to their facilities for manufacturing and the superior quality of their shop work, has given them an enviable reputation and a success, which can be in part measured by the fact that in the last 20 years they have built and sold about 2,000 Corliss engines, some of them being the most notable examples of steam engineering in this country.

In the accompanying engraving we illustrate one of the cross-compound horizontal engines of the "1890" design. This engine is built in sizes ranging from 150 to 3,000 horse-power, and is looked upon as a standard for power purposes and also for electric service. For the latter work the engine is arranged to carry the electric generator mounted on the shaft alongside the fly-wheel. In that form of construction a square rimmed fly-wheel is used instead of the wide-faced wheel shown. This engine is also built as a tandem compound when desired; the economy is the same, the choice between tandem and cross-compound depending upon which is the best adapted for the available space.



Cross-Compound "1890" Engine.—Built by the Edward P. Allis Company.

The engine was designed to meet the conditions arising from the introduction of economical engines in rolling mills, and the rapid growth of electric street railway work, as well as the employment of higher steam pressures. It is peculiarly adapted to this extraordinarily trying service, and the design will commend itself to all competent to judge. The form of bed-plate is believed to be the best so far devised, giving the best possible support to the main journal and entirely eliminating all lateral strains. The parts have all been made very large, and exceed in size and weight those of any engine of like size cylinder manufactured. The company guarantees these engines to operate continuously under a steam pressure of 150 pounds per square inch, and in any service.

The valve gear used on the engines was introduced in substantially its present form by Mr. Reynolds in 1876. Its action is perfect, imposing little or no work on the regulator, thereby securing the closest regulation, and it can be operated at speeds usually deemed impracticable with a drop cut-off gear.

All materials used in the construction of these engines are subjected to rigid physical tests under the direction of competent engineers. The requirements are the same as exacted by the United States government and the leading railroad companies. The cylinders are made from carefully selected iron, remelted, as experience has shown that the most durable cylinders are not necessarily the hardest, but the cleanest. The purer the iron from which they are made the better the cylinders will wear. The company selects a variety of irons best adapted to the purpose, a considerable portion being charcoal irons, and these are melted and run into pigs. From these pigs remelted, the cylinders, valves and piston packing rings are cast. This process insures exceptionally fine castings, and the increased durability of the cylinders warrants the additional expense.

Equal precaution is observed in the selection of irons used in balance wheels: and to this, as well as excellence of design, is due the fact that of many hundreds of wheels of all sizes up to 40 feet in diameter, made at these works, not one has proven defective in practice.

The care bestowed on the selection of iron for use in cylinders and wheels is extended to all parts of the engine where castings are employed, each part being made of such irons as experience has proven best for the particular purpose. Bronze castings are used for valve stems and all other places where that metal is required. Piston rods, connecting rods, crank and cross-head pins are made of steel. Hammered iron is used for the main shafts. All bolts and studs about the engine are made of double-refined iron or mild steel. The main journal bearings, cross-head shoes and crank-pin brasses are faced with genuine babbitt.

Many notable engines of this type have been built by the company. The power plant of the Brooklyn Street Railway Company might be mentioned. It consists of six engines, with a rated capacity of 2,000 to 3,000 horse-power, and eight engines, rated at 1,000 to 1,600 horse-power. In the works of the company there are now under construction three of these engines, each of 1,200 horse-power, for one of the large mining companies near Johannesburg, South Africa, and another order of these engines has just been shipped to South Africa.

The special engines built by the company are numerous, and like this standard type illustrated, are sent to all parts of the world.

Arbitration Committee Decisions.

At a meeting of the Arbitration Committee of the Master Builders' Association, held Dec. 16, 1896, the following subjects were considered worthy of a ruling:

When scrap credits are allowable the weights credited should always be equal to the weights of the new metal applied, except as otherwise provided in the Rules and in Section D of leaflet No. 1, Sept. 16, 1896.

Several inquiries as to the meaning of the words "switching roads," in Section 25 of Rule 5, were considered, and the committee makes the following ruling as a definition of a switching road as used in this connection: A switching road is a corporation doing the major part of its business on a switching charge, or one which does not pay mileage to car owners for the use of the owner's car.

The Cost of Armor Plate.

On Jan. 5 Secretary Herbert sent to Congress a report on the cost of armor plate that has created considerable of a sensation. Last summer Congress passed a resolution authorizing an examination into the actual cost of armor plate, and a recommendation as to the price for armor that would be equitable. This report of Secretary Herbert is the result. In making his investigation the Secretary classed the sources of information and their availability as follows:

"1. The contractors for armor. They, of course, could, if so disposed, give me full and accurate information as to the cost of their plants and of the manufacture of armor.

"2. The naval officers who had been stationed at the works of the armor manufacturers as inspectors. These officers did not have access to the books of the contractors and could not be expected to give very accurate information as to the cost of the plant, but they had opportunities to know about the cost of material and the character and amount of labor employed.

"3. The prices of armor abroad, though already known in great part, could be more thoroughly inquired into and compared with the prices being paid by the government.

"4. The cost of erecting the armor plants, which was a material portion of the inquiry, could not be ascertained with absolute accuracy without an inspection of the books of the contractors. If they should fail to furnish the proper information, an inquiry into the price at which similar plants could at present be erected would throw light upon the subject. This inquiry into the present cost of erecting armor plants seemed to be all the more material because the Naval Committee of the United States Senate, when it began the investigation which resulted in the enactment of the law calling for this report, had before it the proposition that the government itself should erect a plant for the purpose of manufacturing its own armor.

"5. Search should be instituted for any reports made by the two contracting companies under the laws of their State to State authorities."

The first mentioned source of information did not yield any figures at first, but after the investigation had made considerable progress along other lines, the Carnegie and Bethlehem companies wrote letters to the Secretary giving some information, and at the same time protesting against disclosing business secrets to competitors. In the letter of the Bethlehem Company the cost of the material and labor involved in the manufacture of one ton of armor is placed at $250. To this they add $78 per ton interest on $4,000,000, the cost of their armor plant, $132 per ton depreciation and maintenance (at the rate of 10 per cent.), and $33 per ton interest on a working capital of $1,500,000. This makes a total of $493 per ton without including administration expenses, cost of experiments, rejected plates, &c. The letter of the Carnegie Company protests that the estimates of naval experts omit interest on the cost of their plant valued at $3,000,000, this interest amounting to $81.53 per ton; maintenance on the plant, $67.94 per ton; loss by abandonment of plant when navy shall have been completed, say ten years from date, $75.49 per ton; or a total of $224.96 to be added to the cost as given by the naval experts.

Turning to the estimates of the costs of plants made by the government inspectors, we find that Ensign McVay in his statement of the plant at Carnegie's estimates the amount at $3,000,000. In that amount he includes $300,000 for stock in hand, and items for land, light and power which aggregate $775,000, or, including the stock item, a total of $1,075,000. Deducting this sum from the $3,000,000 leaves $1,925,000 as the cost of the plant without ground, power or light. The company claim, however, that the cost was $2,500 000 exclusive of the items of ground, railway connection, water plant, power and light plants, these being taken from their other works.

The Rohrer board estimated the cost of the armor plant of the Bethlehem Iron Company at $1,881,000, or $881,000 more than the amount on which the company figure interest in their estimates. There is no doubt but that the Bethlehem plant did cost more than the Carnegie. The Secretary believes that it would not be unjust to allow in the estimates $1,000,000 more for the plant at Bethlehem than for that at Carnegie's.

During the Secretary's visit to Europe he procured two estimates of the cost of armor plants.

"One of them was made in England by a company which is prepared to furnish the plant. This estimate by a manufacturer of experience and reputation puts as a sufficient sum for machinery £113,400, but it having been referred to the Chief of the Bureau of Ordnance to be completed by adding estimates for duties, buildings, installation, etc., he has added these and other costly items which he deems necessary to make it equal the American plants. As thus completed it amounts to $1,590,000. This is the estimate for putting up complete a plant equal to that of the Carnegie Company, said to have cost $3,000,000. Prices are, however, lower now than in 1887, when the Bethlehem Company began their plant, or even than in 1890, when the Carnegie Company undertook the manufacture of armor."

Secretary Herbert then describes the formation of a board consisting of Lieutenants Rohrer, Niles and Ackerman, which was instructed to make a careful estimate of the actual cost in labor and material for the manufacture of armor. This board reported that the cost of labor and material in a ton of single forged Harveyed nickel steel, the government supplying the nickel, was $167.30. An allowance of 10 per cent. for rejections and $11.27 per ton for reforging brought the cost of reforged armor up to $197 per ton. This, the Secretary states, is a very liberal estimate to the contractor.

The Secretary then proceeds to estimate the profits of the two companies on their armor plate business from the time their plants went into service until June 30, 1897, and he reaches the conclusion that in the case of the Bethlehem Company, the earnings of the plant are sufficient, "after paying 22 per cent. on all money put into new plants from date of issue of stock and until its cancellation, to repay their stockholders in full and accumulate a surplus of $1,434,222, sufficient to more than pay off their bonded debt of $1,351,000. These calculations above show net results; only net earnings have been considered and the results show that company's investments in plant to make armor and gun steel for the government have returned 23 per cent. thereon."

The basis of the above estimates is the reports made by the company to the Auditor-General of Pennsylvania.

There were no such reports from the Carnegie Company and the estimates regarding the latter company's business have, therefore, been based on the best available information as to the value of their plant and the cost of manufacture of the armor. This plant has not been in operation as long as the Bethlehem plant, but from June 30, 1892, to June 30, 1897, the Secretary estimates that the profits have been and during the next six moths will be under existing contracts, sufficient to pay five per cent. interest on $750,000 working capital, five per cent. maintenance annually, ten per cent. dividends and to practically extinguish the entire first cost of the plant ($3,000 000) by the surplus accumulated.

The Secretary next takes up the question of what would be a fair price for armor. He says in part:

"What, then, will be a price sufficient to justify manufacturers in maintaining armor plants? These two contractors, we have seen, have already been repaid the cost of their plant, together with fair profits thereon. It has been determined that the cost of the labor and material in a ton of double forged nickel steel Harveyed armor, including allowances for losses in manufacture, is $196.45. This comprises every element of cost in its manufacture save and except only the maintenance of plant. I allow in this calculation 10 per cent. for maintenance.

"The present value of an armor plant like those of the companies referred to—the price at which such a plant could be erected—is, according to the figures heretofore attained, $1,500,000 the allowance for maintenance, $150,000 per annum while the plant is in operation. If we suppose that 2,500 tons of armor are manufactured per annum, this will give an average per ton of $60, which, being added to the cost of labor and material, will make in round numbers $256. If 3,000 tons per annum are manufactured the price of each ton would be ascertained by adding $50 to the $196, or $246, so

that we may take $250 in round numbers as the cost of a ton of armor when the companies have fair orders for work."

The Secretary then takes up the Bethlehem contracts for armor for Russia and shows that the price in the first order, $249, is close to to the estimates of the actual cost of armor. If with freeght charges and the cost of nickel added, it led to the conclusion that the order was filled at a loss, the next order of 1,137 tons at $520.70 per ton shows the profits the company expected to realize in the European markets. "If there was no loss in the first contract at $249, there was an immense profit in their next contract at $520.70. If there was a loss on each of 1,400 tons (the first order) it could not have been very great or the company could not expect to recoup except by reasonable rates on large contracts, which they could have little reason to expect in Europe."

"It is essential, as has already been stated, that these or other armor plants be kept in operation, or at least be maintained in readiness for government work, and such prices must be paid as will satisfy contractors that they will be remunerated for maintaining plants.

"It therefore seems to me that under all the circumstances, considering the uncertainty of future contracts and in view of the fact that these contractors have heretofore established plants on the faith of orders they were to receive thereafter from the government, it would not be inequitable to allow them 50 per cent. upon the cost of manufacting armor for the three ships now under contract. Fifty per cent. added to $250 would be $375, but it is to be remembered that the government has heretofore furnished the nickel, and that the item of $196 for labor and material does not cover the cost of the nickel.

"It is, therefore, suggested that in future contracts manufacturers shall be required to furnish their own nickel. Adding $20 for this item to $375 we have $395 per ton, and allowing something for keeping nickel on hand, we have in round numbers $400 per ton. This seems to be a fair and equitable price to pay for armor for the *Wisconsin*, *Alabama* and *Illinois*.

"If Congress at this session should authorize two or more battleships, I would suggest as a price to be paid for the armor of these and the foregoing battleships $375 per ton. Upon the larger order the contractors could well afford to allow a reduction of $25 per ton.

"I may be possible that the contractors may refuse to accept contracts at the price herein recommended. If Congress should determine that these prices, or any other, are fair and equitable, and shall decide not to pay any more, it should determine upon the course it will pursue in case the contractors refuse to accept its conclusions.

"I recommend that if Congress shall determine by law upon any limit of price to be paid, it shall also authorize the Secretary of the Navy to erect or buy an armor plant, and a gun plant, and if need be to lease such plant or plants until it can construct its own."

Electric Power Transmission to Buffalo.

On Jan. 12 there was a banquet in Buffalo, given by the Cataract Power and Conduit Company to eminent business men and engineers in celebration of the transmission of electrical energy from Niagara Falls to Buffalo. Nearly 400 guests were present. Among the addresses was one by Mr. Stetson, one of the directors of the company, in which he gave some interesting facts bearing on this great enterprise. Regarding their franchise he said that it required that on or before June 1, 1897, the company should be prepared to supply 10,000 horse-power to consumers within the city, and with this condition the company has so far complied that upon the first day of December, 1896 (six months before the specified date), it introduced into the city of Buffalo 1,000 horse power, which from that time on has been satisfactorily employed by the enterprising, intelligent and public-spirited directors of the Buffalo Street Railway Company, to whose justifiable confidence in the sufficiency and continuity of Niagara power the city of Buffalo is indebted for this early introduction.

"It is, however, proper to observe that a reasonable postponement of the date before which the remaining 9,000 horse-power shall be required to be ready for use in this city will be necessary. It is entirely credible that, like the business men of every other city of the United States, the citizens of Buffalo found the spring and summer of 1896 exceptionally unfavorable for the promotion or prosecution of business enterprises involving novel elements, or calling for the expenditure of considerable sums of money. But whether or not this were so in Buffalo, it is true that during the year 1896, and prior to Nov. 4, few corporations undertook or accomplished in the way of new construction more than did the Niagara Falls Power Company and the Cataract Power and Conduit Company in the installation of the line for generating and transmitting the Niagara Power now in use in the City of Buffalo. Naturally enough, all desired that such installation should be established with such care as to avoid, so far as possible, the chance of failure and disappointment in operation, and, therefore, it was deemed best not to provide all the new machinery required for 10,000 horse-power until after the actual test of the transmission of the 1,000 horse-power, for the delivery of which upon Dec. 1 Mr. Littell contracted in August, 1896.

"The actual test having been made with results wholly satisfactory, the Niagara Falls Power Company now has concluded its contracts for the immediate generation of not merely 10,000 but of 25,000 additional electrical horse-power, of which as much as required will immediately thereupon be available for transmission to Buffalo. The contracts for this purpose have been actually assented to, and the money therefor has been actually provided.

"The contract for an extension of the wheel pit sufficient to receive all the machinery for 50,000 electrical horse-power was made in 1896, and work thereunder has been and now is proceeding with the stipulation for its completion during the month of May, 1897."

Hill Climbing with 22 by 28-inch Consolidation Engines.

Mr. Harvey Middleton, General Superintendent of Motive Power of the Baltimore & Ohio Railroad, has recently tested the Pittsburgh Consolidation Engines Nos. 16.8 and 1624, on Cranberry grade. These engines are among those recently delivered to the company. From Mr. Middleton's report we take the following:

"On Dec. 3, 1896, a trial of the two 22 by 28-inch Pittsburgh Consolidation Engines Nos. 1628 and 1624 was made on the Cranberry grade. Engine 1628 at the head of the train was run by Engineman P. J. Moran, with engine 1624, Engineman S. H. Dunning as helper. Engine 1628 was run through from Cumberland to Rowlesburg, where the fire was cleaned at front end and the old sand removed from the sand-box and the box filled with sharp river sand. Engine 1624 also had its box filled with this sand.

"The train consisted of 24 hopper gondola cars and a caboose. The gross weight of train, exclusive of caboose, was 2,046,699 pounds, or 1,023 tons; with caboose, 11 tons additional, or 1,034 tons. Gross weight of train, including engines and caboose, 1,202 tons. The rise of the grade is 116 feet per mile, with numerous curves. In the construction of the road no diminution of the grade was made at the curves to compensate for the additional resistance, and consequently it is much more severe than the figures, 116 feet to the mile, would indicate. The usual running time of a train over this grade is between two and three hours.

"The day was clear and cold. The train started from coal chute at Rowlesburg at 1:29 p. m., and arrived at Terra Alta at 3:05 p. m., a distance of 12.3 miles in 1 hour and 36 minutes. Of this 13 minutes was consumed at No. 42 Water Station, leaving a net running time of 1 hour and 23 minutes. The steam pressure on the forward engine was 180 pounds, the pop blowing off all the way up the hill; the helping engine had a pressure of from 170 to 180 pounds, most of the time from 175 to 180. Engine 1628 slipped her wheels only about 6 revolutions during the trip up the hill; engine 1624 not at all, nor was it necessary to relieve the cylinders by opening the cylinder cocks in starting the train. The start was good and strong, without any slipping of the wheels such as is usually experienced in starting a train on this grade. The injectors were feeding the boilers all the way up the hill on both engines.

"Engine 1628 took the train from Terra Alta east, leaving Terra Alta at 3:31 p. m. and arriving at Altamont at 4:23 p. m., a distance of 18.8 miles in 1 hour and 2 minutes. It left Altamont at 4:32 p. m. and arrived at Piedmont at 5:30 p. m., making the distance from Terra Alta to Piedmont, 35.6 miles, in 2 hours and 9 minutes. The total distance from Rowlesburg to Piedmont, 47.9 miles, was made in 3 hours and 32 minutes."

Engineers' Club of Cincinnati.

The ninth annual meeting of the club was held on Dec. 17, at which time the following officers for 1897 were elected: President, Chas. F. Lindsay; Vice-President, G. W. Kittredge; Directors, W. B. Ruggles, A. O. Elzner, S. Whinery; Secretary and Treasurer, J. F. Wilson.

Civil Engineers' Society of St. Paul.

A regular meeting of the Civil Engineers' Society of St. Paul was held on Jan. 4. The annual election resulted in the following list of officers for the year 1897: President, K. E. Hilgard; Vice-President, Oliver Crosby; Secretary, C. L. Annan; Treasurer, A. O. Powell; Librarian, A. W. Münster; Representative on the Board of Managers of the Association of Engineering Societies, E. E. Woodman.

A Large Carbon Steel Plate.

The works of the Carbon Steel Company, Pittsburgh, are fully equipped with modern machinery, and the excellence of the material turned out by this company is attested by the frequency with which it is specified in locomotive and other boiler work. Their machinery is large enough to turn out plates of great size, an example of which are a number of firebox plates 196 inches by $114\frac{1}{2}$ inches by $\frac{9}{16}$ inch, rolled by them. A more remarkable plate is a test plate rolled for the United States Government. It is 152 inches by $114\frac{1}{2}$ inches by $1\frac{7}{16}$ inches. This plate weighs 7,200 pounds and was made to a very rigid specification and one not easy to fill. The tensile strength was to be 65,000 pounds, and two test pieces gave 67,660 and 65,200 pounds, respectively, the elongation of the former being 24.7 per cent. and of the latter 25 per cent. in 8 inches. A transverse test piece was bent over close on itself without a sign of fracture. The chemical analysis of the plate gave the following result ;

Carbon	.31
Manganese	.35
Phosphorus	029
Sulphur	.023

The government specifications called for 24 per cent. elongation in longitudinal specimens, 22 per cent. in transverse specimens, and that the latter should bend double over a mandril $1\frac{3}{16}$ diameter. The plate more than met the requirements in every particular. The ability of the company to turn out such a large boiler plate of so excellent a quality demonstrates the capacity of its plant and the excellence of its processes and general product.

An Improved Air Hoist.

The straight lift pneumatic hoist shown in the accompanying engraving is of improved construction, and built by the Pneumatic Engineering Company of 160 Broadway, New York City. In the smaller sizes, seamless drawn brass tubing is used for making the cylinders, while for those of larger proportions and a greater length of lift, seamless drawn steel tubing is employed. In some special cases the cylinders are constructed of cast iron. A hoist giving a 4-foot lift is the size used in most shops. They are, however, furnished with a length of lift ranging all the way from 3 to 20 feet, and a capacity of from 200 to 20,000 pounds.

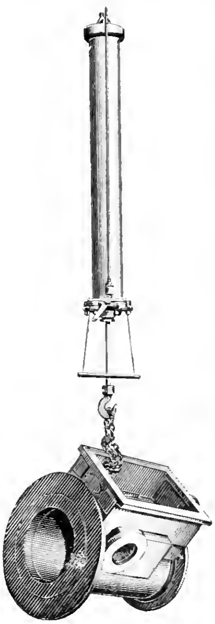


Fig. 1.—An Improved Air Hoist.

A good feature of the hoist which we show is the attachment of the air valve to the cylinder, instead of to the lower head, as is the usual practice. This admits of the head being removed the same as a steam cylinder cover, and without disconnecting the air pipe or detaching the cylinder from the trolley or crane. The hook, which carries the load hoisted, is swiveled to the lower end of the piston rod in such a manner as to require the least possible amount of room. This is an advantage worth considering where head-room is limited. The piston rod is fitted with a gland containing a packing and requires practically no attention beyond being oiled occasionally.

One of the most important features of hoists of this class is the air valve. In the lift shown the valve is a model of simplicity in its construction, and we are informed is very reliable and economical in its working. Air is admitted to the hoist by the movement of a lever in one direction and exhausted by reversing it. Regulation can be secured from a scarcely perceptible motion of the piston to full speed at will. It is a lift valve provided with a soft rubber seat, in consequence of which it will not leak with wear, neither will dust or dirt keep it from closing tightly. Ready access for examination is provided. The valve closes automatically (holding the piston at any point desired) whenever the operating lever is released. The result is a great saving in air compared with hoists having valves which must be closed by hand.

The area over which these hoists can be operated is almost unlimited, and is accomplished by means of a quickly operated hose coupling valve, and by having live air drop-hose connections in convenient places, or wherever there is lifting to be done.

Horizontal hoists are fitted either with or without multiplying sheaves, according to circumstances, and in some cases they are

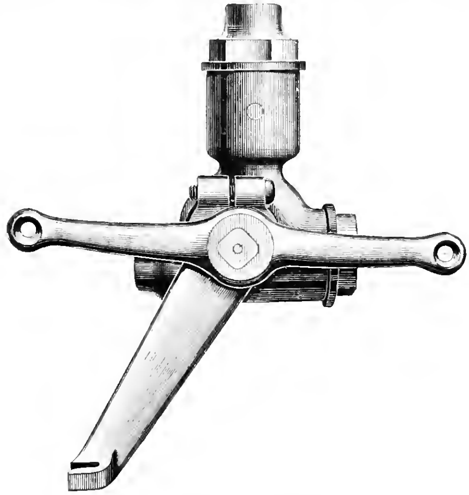


Fig. 2.—Improved Air Hoist Valve.

made to telescope, thus securing a high lift with a short cylinder. These patterns are necessarily more complicated and expensive than the straight lift style and should be used only where sufficient head-room cannot be obtained for the usual pattern.

This improved air hoist is well adapted to take the place of chain blocks and hand cranes of all kinds, and is used very generally in machine shops, architectural iron works, boiler shops, bridge works foundries, power stations, etc., etc. As a foundry hoist its use enables the molder to open his flasks without other help.

The Sargent Company's Steel Castings.

We mentioned last month the excellence of the steel castings being turned out by the Sargent Company, of Chicago. We present herewith two tables, the first of which gives the physical properties of their open-hearth castings as evidenced from six heats, while the second table compares the qualities of their open-hearth steel with the U. S. Government specifications:

TABLE 1.—PHYSICAL PROPERTIES OF THE SARGEANT COMPANY'S OPEN HEARTH STEEL CASTINGS.

Heat No.	Tensile strength per square inch.	Per cent. elongation in 8 inches.	Reduction of area.
E 138	67,800	22.5	41.5
E 141	60,200	24.8	46.6
E 142	64,700	23.3	44.7
E 144	59,300	24.8	46.9
E 149	60,500	26.2	45.4
E 154	62,200	25.5	52.5

TABLE 2.—SARGEANT COMPANY'S STEEL CASTINGS COMPARED WITH U. S. GOVERNMENT SPECIFICATIONS.

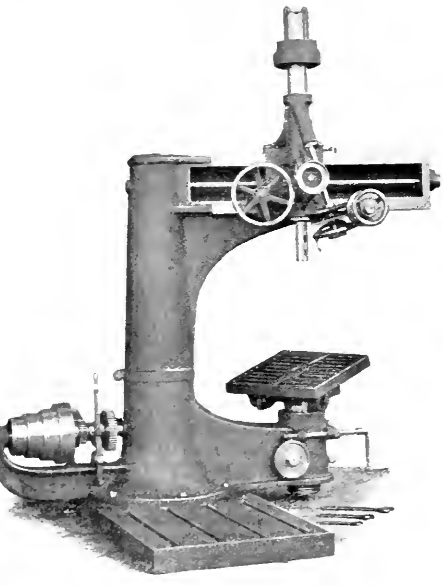
Physical properties.	U. S. Government Specifications.	Sargent Company's averages.
Tensile strength, pounds per square inch.	60,000	62,450
Per cent. elongation	in 2 inches, 18.	in 8 inches, 24.5
Per cent. reduction of area	not specified.	46.3
Per cent. phosphorus	under 0.06	under 0.04

The company has been doing an excellent business with railroad companies in furnishing them steel castings. As an illustration, in

some of the latest Rock Island engines there were 21,573 pounds of steel castings used per engine and all of these except the frames were furnished by the Sargent Company. The order included driving boxes, foot-plates, engine truck center plates or "spiders" and driving wheels. The saving in the weight of the four driving boxes was 472 pounds, foot-plate, 549 pounds; engine truck center, 631 pounds; and the saving in the weight of driving wheel centers was as usual very large.

A Six-Foot Radial Drilling-Machine for Boiler Work.

The well-known firm of Bement, Miles & Company have recently built their five and six-foot radial drills for boiler work from a new design, which we illustrate herewith. This design gives a very strong machine and permits several variations to be made to suit the needs of customers. The table can be made adjustable, as shown, or a plain square box table can be substituted. The machine can be built as a plain radial drill or the head can be made to swivel, the arm to rotate and to raise and lower, making the machine entirely universal, or any one or more of these motions can be provided for without necessitating the others. The sleeve carrying the arm rotates on steel balls to reduce friction. The table, as shown in illustration, rotates on its axis, has a vertical adjustment of 10 inches by a circular rack on the supporting column, operated by worm and worm wheel, and can be set horizontally, vertically or at any intermediate angle. When the machine is to stand on the



A Six-Foot Radial Drilling Machine.

ground floor, the circular rack can be lengthened, as required, to give an increased vertical adjustment to the table.

Like all the other tools made by this company, the best of workmanship and materials enter into their construction. The drills are built in sizes, from 4½ feet to 10 feet, the size indicating the distance from the center of the column to the end of the arm. Some particulars of these sizes are given in the following table:

Feet.	Will drill in center of circle.	Greatest distance spindle to Base plate.	Greatest distance spindle to Table.	Traverse of spindle.
4½	84 in.	52 in.	26 in.	12 in.
5	90 "	57 "	37¾ "	14½ "
6	110 "	67	40½ "	18 "
7	138 "	66	40 "	20 "
8	156 "	64 "	....	18 "
10	200 "	83 "	....	21 "

The main office of the company is at the works in Philadelphia. It also has a New York office at 39 Cortland street, and a Western office at 1534 Marquette Building, Chicago, Ill.

A Large Electric Line Projected.

Articles of incorporation have been filed with the Secretary of State of Ohio for what will be the biggest electric railroad system in the world, if the scheme is carried out. The articles were filed by Hon. Harry Probasco, as counsel of the company, and the charter was issued without delay. The project contemplates the making of an electric road of the entire Cincinnati, Hamilton & Dayton Railway system between Cincinnati and Toledo and also between Dayton and Ironton. The new company is to be known as the C., H. & D. Traction Company, and under the articles of incorporation it is authorized to lease, own, acquire, build, operate or maintain, either alone or in conjunction with any other street, surburban, interurban, or other railway company of street, surburban or interurban railways, to be operated by electricity, steam or any other motive power, to do a freight and passenger business. The capital stock of the company is $50,000, in $100 shares. The incorporators are C. G. Waldo, D. G. Edwards, Geo. R. Balch, R. P. Rafenberick and C. A Wilson. The capital stock of the company, while small, it is expected will be enlarged very materially at a later date, the object being for the first operation to equip the line between Middletown and Hamilton, which can be done at a very small expense, the track and roadbed being all complete. From the experience acquired in this initial plant, it is said the development of the line of the C., H. & D. Ry. between Cincinnati and Hamilton and other points will be carried on.

EQUIPMENT AND MANUFACTURING NOTES.

The Northern Pacific is figuring on new passenger equipment for spring delivery.

The C. & E. I. Railroad is asking bids on from 250 to 700 coal cars, of 40 tons capacity.

The Baldwin Locomotive Works have delivered six new engines to the Union Pacific, Denver & Gulf.

The Missouri Car and Foundry Company's Works at St. Louis, Mo., were damaged by fire on Jan. 2.

The Berwind-White Coal Mining Company has ordered 150 freight cars from the Middletown Car Works.

The Chicago & West Michigan has placed an order for one engine with the Baldwin Locomotive Works.

The Midland Terminal Railroad has placed an order for five locomotives with the Schenectady Locomotive Works.

The Bath Iron Works, Maine, have been awarded a contract for two lightships and one lighthouse tender, to cost $320,000.

The ten locomotives for the Kansas City, Pittsburgh & Gulf Railway have been placed with the Baldwin Locomotive Works.

The Wells & French Company is building 300 cars for Armour & Company, of Chicago, of which 200 are fruit cars and 100 are for beef.

Mr. Geo. W. Ristine, Receiver and General Manager of the Colorado Midland, has ordered 180 box cars from the Pullman Company.

The St. Charles Car Company are building 100 new coal cars for the Union Pacific, Denver & Gulf, which are to be equipped with the Selden coupler.

J. A. Ellis, whose office is in the Monadnock Block, Chicago, has been appointed Western agent for the Dickson Manufacturing Company, of Scranton, Pa.

The Weimer Manufacturing Company, of Lebanon, Pa., have orders from the Carnegie Steel Company for 16 steel cinder cars for the Edgar Thompson Works.

The Ross-Mehan Foundry Company, of Chattanooga, Tenn., is building additional furnaces in its malleable department, by which its capacity will be doubled.

The National Electric Headlight Company, of Indianapolis, has received an order for three more electric headlights from the Texas Midland road, where seven are now in use.

The Ohio Falls Car Manufacturing Company will build for the Charleston & Western Carolina Railway 375 freight cars, 10 cabooses and 15 or 18 passenger and baggage cars.

The Consolidated Car Heating Company has recently equipped the private car of President Blair, of the Wheeling & Lake Erie Railway, with its standard drum steam-heating system.

The Lebanon Manufacturing Company, of Lebanon, Pa., have an order from the Cornwall & Lebanon Railroad to equip with air-brakes and automatic couplers 200 freight cars recently repaired.

The Mack Injector Company will remove to Lynn, Mass. The company have been located in Boston. They manufacture steam injectors for locomotives and do a general line of machinery business.

The Morgan Engineering Company, Alliance, O., have received a contract from the government for nine Buffington-Crozier model of 1891 gun carriages. The contract calls for the completion of the carriages within one year.

The Mason Regulator Company, Boston, Mass., have a contract for about 25 reducing valves, for the Liondale Dye, Bleach and Print Works, Rockaway, N. J.; also all the pressure regulators for their pumps, and a hydraulic damper regulator for the boilers.

McKee, Fuller & Company, through their Western agent, Mr. J. L. Woods, have just sold 70 36-inch coach wheels to the Chicago, Rock Island & Pacific Railroad, for replacements, and 160 locomotive truck wheels to the Chicago, Milwaukee & St. Paul Railway.

The 180 freight cars which have been ordered by the Colorado Midland Railway will be equipped with the American Steel Foundry Company's bolsters. This company's bolsters will also go under 163 refrigerator cars being built for the Armour Packing Company.

The Hancock Inspirator Company announces to its patrons and the trade in general that on and after January 1, of this year, it will conduct the sale of its goods direct. All orders will receive proper attention and prompt shipment. Prices and discounts will be quoted upon application.

The Falls Hollow staybolts have been specified by Mr. R. H. Soule, Superintendent of Motive Power of the Norfolk & Western Railway, for the seven consolidation engines building for that road, the bolts to be used in such portions of the side sheets as are subject to the greatest strains.

The Kansas City, Pittsburgh & Gulf Railroad has placed an order with the Barney & Smith Car Company for 100 box cars. These cars are to be equipped with the Chicago roof, Tower couplers and Pickering springs, and it is probable that the road will order at least 1,000 cars during the coming year.

H. K. Porter & Company, of Pittsburgh, are building two compressed-air locomotives of 18-inch gage, one for a copper mine in Montana and the other for a silver mine in Idaho. A test of a similar motor was made recently with and without reheater, and it is said to have given very satisfactory results.

The Mexican Central Railway has prepared specifications for 570 freight cars, of which 350 are to be box. It is understood that the specifications will be submitted for proposals within the next two or three weeks, and that the order will be awarded on the return of President A. A. Robinson from Europe in February.

The Henry R. Worthington Company, manufacturers of pumping machinery, have received word that the exhibit of Worthington pumps at the Hungarian National Exhibition, at Budapest, has been awarded a grand Millennium medal. This medal is the only award made for pumping machinery at the exhibition.

The Dickson Manufacturing Company, Scranton, Pa., is building a double pumping engine for the city water-works of New Bedford, Mass. It is also building large sluice gates for a drainage canal in the City of Mexico. It also has considerable work for the Calumet & Hecla Mining Company, and a contract for six locomotives.

Recent sales of the Beaudry Champion power hammer have been made by Beaudry & Company, 162 Commercial street, Boston, Mass., to B. & S. Massey, Manchester, England; J. M. Arthur & Company, Chicago, Ill.; Gilman Carriage Works, Worcester, Mass. and the Massachussetts Institute of Technology, Boston, Mass.

The United States Circuit Court of Appeals on the 7th of January rendered a decision in favor of the Chicago Pneumatic Tool Company, in the suit of the American Pneumatic Company against the Boyer hammer, thus confirming the position which the former company has always taken, namely, that the Boyer hammer did not infringe the American Company's patents.

The Missouri Malleable Iron Company, of East St. Louis, Ill., is erecting a number of annealing ovens to give an additional capacity of 5,000 tons per annum to its plant. The company states that this addition was made necessary from the fact that it has secured a number of contracts from railroad companies and car builders and several large contracts from coupler companies.

The Wellman-Seaver Engineering Company, Cleveland, O., have recently furnished two Wellman charging machines for open-hearth furnaces to the Carnegie Steel Company, also one machine for the open-hearth plant of the Buhl Steel Company, Sharon, Pa.; one for the Lukens Iron & Steel Company, Coatesville, Pa., and; one for the Otis Steel Company, Limited, Cleveland, O.

The Bethlehem Iron Company has closed a contract for a hollow-forged tempered steel shaft for the new steamer *Queen City*, of the Pittsburgh and Cincinnati Packet line. The shaft will be 37 feet long 14 inches outside diameter and 7 inches inside diameter. The saving in weight will be about 5,000 pounds even though the strength is greater than would ordinarily be provided in a solid shaft.

The Morton Manufacturing Company, Muskegon, Heights, Mich., have recently received orders for export for one 30-inch stroke shaper to Lobnitz & Company, Renfrew, Scotland; one 36-inch stroke shaper, James & George Tomson, Clydebank, near Glasgow; one 30 inch stroke shaper, Workman, Clark & Company, Belfast, Ireland; one 24-inch stroke shaper with key seating attachment, Adolph Janssens, Paris.

We have received so many excellent calendars for 1897 at this office that we cannot take the space to notice them separately. Most of them are tasteful and neat, none more so than those of the Ashton Valve Company, of Boston; Falls Hollow Staybolt Company, Cuyahoga Falls, Ohio; Vulcan Iron Works, Toledo; Gould Manufacturing Company, Seneca Falls, N. Y., and Rhodes, Curry & Company, Amherst, N. S.

"Out of the many car builders all over this country," said a prominent export firm, "there are four that actually cater to the export trade. If some of the others would look into the growing export trade it would pay them. Next year's business in this direction will be much more satisfactory than last. Chili, Argentine and Mexico will take double the amount, to say nothing of the far East, etc., etc."—*Railway World.*

The Sargent Company, Chicago, recently shipped to the Pioneer Electric Power Company, Ogden, Utah, a steel flange casting, 6 feet 1½ inches internal diameter, two flange castings 4 feet 7⅜ inches internal diameter, and one breeches pipe 6 feet internal diameter. The weight of the breeches pipe is 10,000 pounds. The casting is designed to stand a pressure of 200 pounds per square inch, but will safely carry a much higher pressure.

The Robert Aitchison Perforated Metal Company has recently received an order for perforated steel plates for the separating department of a large Eastern iron mine. The order will require almost a carload of steel plates. The fact that this order came entirely unsolicited from the mining company, and without even asking for quotations, is in the highest degree complimentary to the Aitchison Company and indicates the great satisfaction with which previous orders have been filled.

The Niagara Power Company has contracted with the Westinghouse Electric Company, of Pittsburgh, for the construction of five 5,000 horse-power dynamos, identical with those already constructed for and in use by this company. It is said that the order includes two more dynamos conditionally ordered. The Niagara Company has also awarded to William Sellers & Company, of Philadelphia, a contract for five turbine governors and five sluice gates. The turbines will be built by the J. P. Norris Company, of Philadelphia.

The American Road Machine Company, of Kennett Square, Pa., and the Aultman Company of Canton, O., have made an important change in the marketing of their improved road and street machinery, and announce that hereafter the entire output of the two concerns in machinery of this class will be sold by the Good Roads Machinery Company, with headquarters at Kennett Square, Pa. This arrangement, it is believed, will prove beneficial to the manufacturer, dealer and the purchaser, and will enable the Good Roads

Machinery Company to offer a choice to its patrons of the very best machines and tools on the market for road-building and repairing.

The Jeffrey Manufacturing Company, Columbus, O., have recently installed a model coal and ash handling plant in the power-house of the Cicero & Proviso Street Railway Company, Chicago. Ill. Coal is carried in overhead storage bunkers from which it is fed to automatic stokers. The coal is received into chutes from which it is delivered to a conveyor which carries it to a crusher, from which it is spouted to a bucket elevator. This will deliver it either to a conveyor that will take it to a storage bin or to another conveyor, by which it is delivered to the coal bunkers above the stokers. The ash is handled by two 12-inch spiral conveyors from which they are carried by a bucket elevator to an ash tank on the outside of the building.

The Gates Iron Works, of Chicago, have entered the high-speed engine business with the Fischer-Gates single and four-valve self-oiling, automatic engines, built according to the design and under the patents of Mr. Fred F. Fischer. Their product will be handled by Messrs. Fischer & Whiteside, 700-702 Fischer Building, Chicago. Plans for extensive additions to the plant of the Gates Iron Works are completed. The catalogue illustrating and describing the features of the Fischer-Gates engine will be ready for distribution in a short time. Orders for these engines are already on the company's books. The reputation of this concern and that of the gentlemen who are associated with them in this enterprise insures the construction of a first-class engine.

On December 31 the Japanese government signed contracts at Washington for the two cruisers to be built in this country for the Japanese navy, as already stated in these columns. One of the new boats will be built by the Cramps, Philadelphia, and the other by the Union Iron Works, San Francisco. The cruisers will be practically alike and will cost about $1,500,000 each. Their length over all will be 374 feet; breadth, 48 feet; extreme depth, 30 feet, and displacement, 4,760 tons. Their speed will be 22½ knots under forced draft. The main battery will consist of two eight-inch guns, with a secondary battery of ten 12-centimeter guns; twelve 12-pounders, and six 2½-pounders. The boats will have twin screws, the engines will be triple-expansion, and the boilers will be of the cylindrical type.

We have received from the Clayton Air Compressor Works, 26 Cortlandt street, New York, a copy of a newly-issued circular on compressed air shop tools and appliances. The circular illustrates and describes all of the prominent articles of this class now offered for sale in the market, and combined with the company's catalogue No. 8, the field of compressed air machinery is very fully covered. In the circular before us the Boyer, Clement and Keller pneumatic tools or hammers are illustrated and described, also the Phoenix portable rotary drill, Manning portable piston air drill, Phoenix pneumatic breast drill, Pittsburgh bridge riveter, air hoists, Manning sand-papering machine, a pneumatic sand sifter for foundry use, air lift pumping system, a pneumatic rivet holder-on, car seat cleaners, a compressed air engine, wire-wrapped hose, fuel oil burners and self-closing air hose couplings. Those interested in applications of compressed air should send for the circular.

Announcement is made of the organization of a new company to take over the plant and business of the Bucyrus Steam Shovel & Dredge Company, South Milwaukee, Wis. The new company is to be known as The Bucyrus Company. It will continue to make all types and sizes of dredging and excavating machinery for every purpose. For its hydraulic dredges this company builds centrifugal dredging pumps, having simple, compound or triple expansion engines directly connected, up to 1,000 horse-power or more. In addition to its well-known excavating and dredging machinery, the company builds pile drivers, wrecking cars, and placer mining machinery. It is considering the enlargement of its crane department, for the purpose of manufacturing not only locomotive cranes, but also special and power cranes of all descriptions. The officers of the new company are: H. P. Eells, President; A. B. Stetson, Superintendent; A. W. Robinson, Engineer, and J. M. Millman, Secretary and Treasurer.

The Tennessee Centennial Exposition will open May 1 and close Oct. 31 of this year. It is to be held in Nashville and is a celebration by the State of Tennessee of the 100th anniversary of its admission to the Union. It is not intended to run the exposition as a money-making affair and hence it has been possible to eliminate some of the objectionable features of other recent expositions. The commerce building is the largest on the grounds and is 500 by 315 feet with wings 150 feet wide. The agricultural building is 525 by 175 feet the machinery building 375 by 138 feet, the transportation building 400 by 125 feet, and the minerals and forestry building 400 by 125 feet. The size of these structures gives some idea of the magnitude of the coming exposition. There are other buildings, including one by the government, an administration building, woman's building, an auditorium, a children's building, etc., so that the exposition promises to be a complete one and a credit to the State. Mr. J. W. Thomas is President of the exposition; Messrs. V. L. Kirkman, W. A. Henderson, and J. Overton, Vice-Presidents; Mr. Chas. E. Currey, Secretary; M. E. C. Lewis, Director General.

Our Directory

OF OFFICIAL CHANGES IN JANUARY.

We note the following changes of officers since our last issue. Information relative to such changes is solicited.

Atchison, Topeka & Santa Fe.—Mr. Geo. A. Hancock has been appointed Assistant Superintendent of Motive Power. James Dunn is Chief Engineer; Mr. C. D. Purden, Assistant Chief Engineer.

Atlantic & Danville.—Mr. Chas. D. Owens, Vice-Preeident and General Manager, died suddenly Jan. 15.

Belt (of Indianapolis.)—President Wm. P. Ijams has resigned, and is succeeded by Mr. D. F. Kinshall.

Chesapeake & Western.—Mr. E. W. Sells has been chosen Vice-President, with office at 30 Broad street, New York.

Chicago, Rock Island & Pacific.- Mr. H. Monkhouse, Assistant Superintendent Motive Power, has resigned.

Chicago & Alton.- Mr. Jacob Johann has resigned the position of Superintendent of Machinery and is succeeded by Mr. H. Monk house.

Columbus, Sandusky & Hocking.—Mr. E M. Poston, of Nelsonville, O., has been appointed Receiver.

Detroit, Grand Rapids & Western —This is the reorganized Detroit, Lansing & Northern; Mr. Charles M. Heald, President; Mr. E. V. R Thayer, Vice President; Mr. Charles Merriam, Secretary and Treasury.

Duluth, Missabe & Northern.—Mr. Wm. Smith has been appointed Master Mechanic, vice Mr. A. F. Priest.

East Broad Top —Mr. F. F. Lyons has been appointed Chief Engineer, with office at Rockhill Furnace, Pa.

Fort Worth & Denver City Railway.—Mr. Morgan Jones, previously General Manager, has been elected Vice-President.

Grand Trunk —Mr. Frank Joy is appointed Assistant Master Mechanic at Gorham, N. H. Mr. W. D. Robb is appointed Master Mechanic at London, Ont., vice Mr. A. H. Smith, resigned.

Gulf, Colorado & Santa Fe.—Mr. Geo. A. Hancock, Superintendent of Machinery, has resigned.

Hutchison & Southern.—J. A. Graves has been appointed Purchasing Agent, with office at Hutchison, Kan.

Interoceanic Puebla.—Mr. E. W. Knapp has been appointed Master Mechanic.

Lebanon Springs.—Receiver Wm. V. Reynolds died last month.

Long Island.—Mr. H. B. Hodges has been appointed Purchasing Agent and Superintendent of Tests.

Texas Central.—Mr. P. T. Mooney, Master Car Builder, has been appointed Master Mechanic also, at Walnut Springs, Tex., to succeed Mr. F. H. Dehn.

Mexico National.—Master Mechanic E. W. Knapp has resigned.

Missouri, Kansas & Texas Railway System.—Mr. S. B. Fisher is Chief Engineer of the Missouri, Kansas & Texas Railway System, with office at St. Louis, Mo.

Mt. Pleasant & Latrobe.—Mr. H. C. Frick has been elected President.

New England.—Mr E. D. Robbins, Hartford, has been chosen Vice-President.

New York, New Haven & Hartford.—The position of Third Vice-President has been abolished.

Oregon Short Line & Utah Northern.—Mr. W. H. Bancroft has been elected General Manager.

San Antonio & Gulf Shore.—Mr. George Dullnig has been appointed Receiver, vice Mr. H. Terrall.

St. Louis, Cape Girardeau & Fort Smith.—General Manager E. S. McCarty has resigned.

St. Clair, Madison & St. Louis Belt.—Mr. J. F. Barnard has been appointed Receiver.

Toronto, Hamilton & Buffalo.—Vice President J. N. Beckley has been elected President.

Wheeling & Lake Erie.—Mr. M. T. Herrick, of Cleveland, and Mr. Robert Blickensderfer, Toledo, have been appointed Receivers.

Youghiogheny Northern.—Mr. H. C. Frick has been elected President.

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

MARCH, 1897.

CONTENTS.

THE ALTOONA SHOPS OF THE PENNSYLVANIA RAILROAD.

IX.

(Concluded from page 44.)

(Concluded from page 44.)

MACHINE SHOP.

This building is one of the best structures of its kind in the country, and is equipped with the most improved tools and machinery that were obtainable at the time it was built. Its size as shown in our June issue is 258 feet 6 inches by 75 feet, two stories in height, and is as thoroughly fireproof as brick and iron construction could make it. It is a model as to lighting, all sides being provided with large mullioned windows, which are carried up as near to the top of the two stories as was practicable—a point which is very much neglected in many shops—notably so in some of the older ones. The absence of ornamentation on the outside of this and the other buildings at Juniata is also very grateful. All the construction is entirely plain, and yet is finished in excellent taste. One feature especially is noticable. All the corners which form the window and door openings are built of rounded bricks. This expedient protects them from being chipped and broken, and has a sort of soothing effect similar to that which results from the rounding of the corners of castings, which is now the universal practice with pattern-makers and designers of machinery who know their business. Some of us can remember when it was the common practice among mechanics to make as lavish use of sharp corners and mouldings in the construction of machinery which were intended to be ornamental.

The interior of the building is constructed of wrought-iron beams and columns, with fireproof floors, all of the most modern and improved character. The first floor is arranged with a central nave, with a traveling crane of 23-ft. span, which traverses its whole length, and is supported on longitudinal beams which rest on wrought-iron brackets attached to the columns. The larger machine tools are located in the center, so that all heavy pieces of work can be placed on them and taken off by the traveling crane. The shop is also liberally supplied with air-hoists and tracks on "runways," with which lighter objects can be handled with great facility. Altogether there are twenty-three such hoists on this floor. The lighter tools are located in bays on each side of the nave. The office for the foreman and shop clerk is located near the center of the shop, and is elevated so as to command a view of the whole floor. The toolroom is below it.

The motive power for the machinery is supplied by two Westinghouse 100 horse-power compound engines, and the building is heated and ventilated by the Sturtevant system. Two hydraulic elevators serve to take work from the lower to the upper floor and vice versa. Our description would assume the character of a mere catalogue if we were to enumerate the machines and tools with which the shop is supplied. As remarked before, it was the original aim to have all these of the most improved kind and that purpose has been carried out to the best of the ability of those who designed the shops. The toolroom especially is a model. The superintendent of this department also has charge of the repairs to all the machine tools in the shop, and is responsible for keeping them in order. Such a man of course should be a specialist in this kind of work, and if he is, the repairs of this kind of machinery is much facilitated.

The practice of making cutters for milling machines out of old steel axles and case hardening them has been adopted here, as well as in the locomotive repair shop, with excellent results. The axles are made of Bessemer steel.

The lighter machine tools are on the second floor, and here, too, the same superiority is noticeable. A special department, which is divided from the rest of the shop, is devoted to brass work and is equipped largely with Warner, Swazey & Company's tools.

ERECTING SHOP.

This building is similar to the machine shop and is 354 feet 6 inches by 70 feet. One of the noticeable features which is located alongside of the western entrance is an admirable wash room for the men. This has porcelain-lined basins, hot and cold water and would be a credit to any ordinary hotel. A wooden pail, which each man had to provide for himself, was all the convenience of this kind which was supplied in shops when the writer was an apprentice.

The machine tools for doing wheel-work are all located at the west end of this shop. The shafting is carried in wooden framework, so that the two traveling cranes can move over it, and they thus serve the wheel-lathes, wheel-presses, and can move the work done here to any part of the shop where it may be needed. A novelty is a wheel-press which can be raised and lowered by hydraulic pressure. Instead of blocking up the wheels in the press, the machine itself is thus brought to the proper height for the work it must do. Air-hoists are provided wherever heavy work must be lifted to or from a machine.

A single track extends through the whole length of the shop, and at the east end there are two short tracks, with pits on each side of the central one. The two traveling cranes run on wrought-iron beams, which are supported on masonry columns. The cranes are each of 35 tons capacity and can run the whole length of the shop. The office is in the middle of the building, with a room for storing bolts and other parts below it. These are all handled in wrought-iron boxes.

At the time of our visit only a small amount of work was in progress. A number of mogul engines, of the same dimensions as the compound moguls described in our October number, were in process of construction. It is the intention to substitute these engines for those of the consolidation type in many places, where the latter have heretofore been used. These moguls have Belpaire boilers, 68 inches diameter, next to the firebox, the front end being 60 inches.

BOILER SHOP.

This is doubtless one of the best-equipped shops of the kind in this country and is 386 feet 6 inches by 80 feet. The west end has a 76-foot electric traveling crane, and also five 3-ton jib cranes, operated by hydraulic power. There is also one gas furnace for heating plates, with a bed 10 by 14 feet, two hydraulic flanging presses, three hydraulic shears, six hydraulic punches, two multiple punches which will punch 70 holes at a time for tank work

and which can be changed to a 60-inch shear when required; one Sellers 5-foot straightening roll, one 6-foot small bending roll and one large 12-foot roll, all operated by hydraulic motors. All punching and shearing machines have jib cranes for handling work.

There is also a No. 5 Hillis & Jones double plate planer 20 feet long, two 4-foot Bement & Miles radial drills, one four-spindle Prentiss drill press for drilling mud rings, one hydraulic riveting machine with 13-foot gap and having a capacity for 45 tons pressure, and another one with 8 feet gap of same kind. Over these riveting machines is what may be called a clear-story which extends transversely to the building and is provided with a 10-ton hydraulic crane for handling the work to and from the machines. This crane has a lift of 40 feet above the track in the shop. Another hydraulic riveter, with a 25-foot jib crane attached to the wall, is used for riveting mud or "foundation" rings in fireboxes. There are also two "walking-cranes" which travel on a single track, bicycle fashion. One of these is operated in connection with a 60 inch gap portable hydraulic riveter and the other with a 14-inch gap riveter which has a universal joint.

Besides these machines there are two Hillis & Jones No. 1½ and No. 2 punches and shears, one flue cutting-off machine and girder, all operated by electric power; a flue tester in which water is admitted to fill the flues from the city mains and pressure applied from the hydraulic accumulator.

PAINT SHOP.

An admirably arranged paint shop also forms one of the cluster of Juniata shops. It resembles in its outfit the passenger car paint shop, which has already been described, although, of course, it is not nearly so large.

From the plan of the shops in our June issue it will be seen that a transfer table was provided for facilitating the movement of cars and engines from one shop to another. It is generally agreed now that this was not essential, and that tracks outside of the shops would provide all the facilities for transfer that are required. As has been remarked in these columns before, a transfer table is a nuisance—sometimes, it is true, a necessary one, but nevertheless one that should be dispensed with whenever it is possible to do so.

Altogether the Juniata shops may be regarded as one of the best equipped establishment in the country. The design of the buildings is especially to be commended. The lighting, heating, ventilation and drainage are all of the best, and the external appearance of the shops manifests the kind of good taste which is controlled by the highest order of utility and good sense.

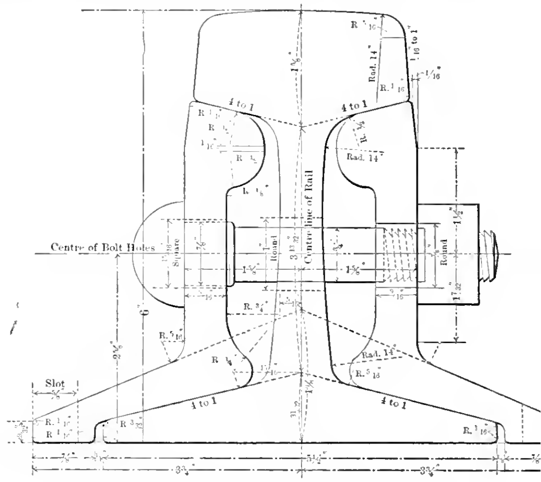
Specifications and Sections for Steel Rails and Angle Splice Bars—New York Central & Hudson River Railroad.

The New York Central & Hudson River Railroad Company is among those who have for years realized that the keeping of track up to a high standard of excellence is an important factor in providing for the greater wheel and train loads required to meet the decreasing rates of transportation. And in raising the standard of the track this company has found that nothing helps more that the use of heavy and stiff rail sections. In 1883 it adopted a 5-inch 80-pound steel rail, which is said to be the first rail section in which stiffness was made a primary rather than a secondary consideration. This same idea has governed the design of later sections including the 80 and 100-pound rails now used. The angle bars used with them are 36 inches long and the joint is supported on three ties, whereas a number of years ago the angle bars were shorter and the joint was supported on two ties. With these improvements and the use of more ballast it is found that notwithstanding the higher train speeds and heavier wheel loads, the inequalities of the track as compared with the old 65-pound rails have been decreased about 50 per cent., where 80-pound rails are used and 75 per cent. where the 100-pound rails are in service, and while this has been accomplished the expense for ties and labor has been decreased.

The improvements which we have noted above have been accompanied by the use of hard and tough steel rails of high elastic limits and the material in the splice bars is also of high-grade steel. The old-style short angle bars wore rapidly near the center of their length, but the greater length of the present standard and the better support of the joint on the ties, combined with the use of a higher steel, has reduced this wear until it is little more in the center than elsewhere, and the joints can be kept in good surface for several years with little trouble.

Mr. P. H. Dudley and Mr. Walter Katte, Chief Engineer of the road, have both given the rail question years of study and last year they got out a new specification for rails and splice bars, which, through the courtesy of Mr. Katte, we are permitted to publish. We also give sections, to a scale of one-half size, of the 80 and 100-pound rails and their angle bars.

The Dudley rail sections are already known to our readers and need no explanation. They embody the results of experience and of the best study of recent years. The heads are wide and shallow, and the metal in the heads bears such a percentage to the total as to insure proper working and a dense, compact metal to receive the wear. The angle bars are 36 inches long for all rails from 65 to 100 pounds, and are secured by six bolts. Those for the 65-pound rails weigh 54.2 pounds per pair, for the 80-pound rails, 64.3 pounds, and for the 100-pound rails, 80 pounds per pair. The tie directly under the joint is protected by a Servis tie-plate. The specifications are as follows:



Section of 100-pound Rail and Splice Bars.—New York Central & Hudson River Railroad.

STANDARD SPECIFICATIONS FOR STEEL RAILS.

1. *Chemical Composition:*

	65 lbs.	70 lbs.	75 lbs.	80 lbs.	100 lbs.
Carbon.............	.45 to .55	.47 to .57	.50 to .60	.55 to .60	.65 to .70
Silicon	.15 to .20	.15 to .20	.15 to .20	.15 to .20	.15 to .20
Manganese.........	1.05 to 1.25	1.05 to 1.25	1.10 to 1.30	1.10 to 1.30	1.20 to 1.40
Sulphur......	.069	.069	.069	.069	.069
Phosphorus........	.06	.06	.06	.06	.06
Rails having carbon below will be rejected....	.43	.45	.48	.53	.60
Rails having carbon above will be rejected..	.57	.59	.62	.65	.70

From the results of inspections of the rolling of the ingots, blooms and rails, and from the drop tests, the Inspector of the railroad company in charge of making the rails shall have the right to select the minimum or maximum limit of either the carbon, silicon or manganese, or the three, as the general guide for the composition, as he may consider the finished product requires to produce a tough rail with as dense fine-grained heads as possible by the plant of the manufacturer.

2. *Blowing and Agitating the Heat.*—The heat to be blown clean in the stack, and, when poured into the ladle, to be agitated by thrusting a green-wood pole into the metal for 10 seconds.

3. *Teeming the Ingots.*—In teeming the ingots for rails no cracked nor patched moulds are to be used, and only a thin, even

wash of "slurry," or its equivalent, will, under any circumstances, be permitted to be used on the inside of the moulds.

The moulds must be filled without undue spattering, at one pouring, and must be maintained in a vertical position until the upper portion—top—of the ingot has solidified. Particular attention must be given to the production of sound ingots.

The steel in the mould must be made to set quiet or "dead" without the use of sand.

Occasional ingots which boil, forming "horns" in the center or corners over three inches high, or steel rising, forming "nigger heads" over three inches high, will be subject to rejection.

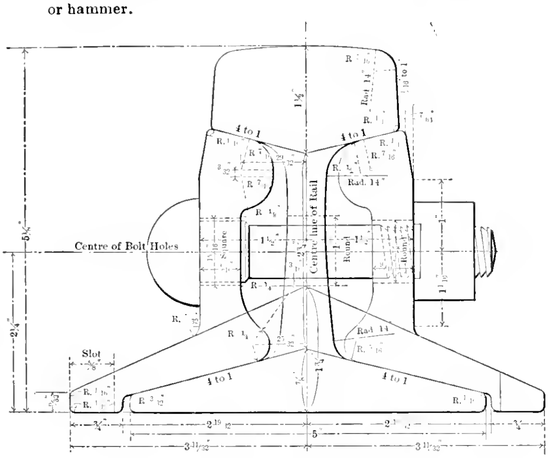
Ingots which have bled—"bleeders"—or from chilled heats, or ingots which have been badly teemed, will not be permitted to be charged into the furnaces or be used for rails under any circumstances.

4. *Test Ingots.*—From each heat, two test ingots shall be cast $2\frac{1}{2}$ inches by $2\frac{1}{2}$ inches by 4 inches long.

One test ingot taken from the metal going into the first ingot poured from the heat, shall be marked "A," and the second test ingot from metal going into the final ingot, shall be marked "B."

As may be designated, either "A" or "B" test ingot or both shall be rolled into bars one-half inch square, and pieces 18 to 20 inches long will be required to bend to a right angle without breaking.

Any form of test bar of about the size mentioned will be accepted which in bending either to a right angle or 160 degrees will stretch the metal on the outside of the bend about 12 per cent. per inch. The bars, however, must be rolled and bent by blows from a sledge or hammer.



Section of 80-pound Rail and Splice Bars.—New York Central & Hudson River Railroad.

5. *Reheating the Ingots and Blooms.*—In reheating the ingots or blooms, care must be taken to avoid overheating or producing a coarse texture in the head of the finished rail.

In no case shall they be reheated until the cinder starts to run when the ignot or bloom is drawn from the furnace or soaking pit.

6. *Cutting the Blooms.*—The sand or top end of each bloom to be cut or sheared off until sound and solid steel is obtained entirely free from sponginess, pipe or exterior scabs.

This matter must have special attention on the part of the manufacturer.

7. *Section.*—The section of the rail throughout its entire length shall conform to the template to be made in strict conformity with the measurements or dimensions on the drawing or blue-print of the section hereto attached or designated.

The fit of the fishing or male template shall be perfectly maintained.

When the rolls are new, the section of the rail must be of its standard height. As the rolling proceeds a variation not exceeding $\frac{1}{64}$ of an inch of excess in height may be permitted in a delivery of 10,000 tons of rails in any one section, after which rolls must be reduced to the standard height for such section.

The standard of measure to be Darling, Brown & Sharpe, United States Standard steel rules.

8. *Rolling.*—The rails to be rolled at as low a heat as possible.

9. *Weights.*—The weight of the rail shall be determined by the top rail of the ingot and shall be maintained as near to standard weight per lineal yard as is practicable in conformity with the provisions in Clause Seventh.

10. *Lengths.*—The standard length of rails shall be thirty (30) feet, at a temperature of seventy (70) degrees Fahrenheit.

Shorter rails of twenty-four (24) foot lengths or over will be accepted to the extent of 10 per cent. of the entire order.

A variation in length not exceeding one-quarter of an inch longer or shorter than the above-specified lengths will be allowed.

11. *Sawing.*—The saws must be kept sharp and care must be taken in sawing to avoid a flow of steel, which will produce a swell in the center of the head or on top of the flanges of the base.

12. *Cambering.*—Rails must not be overcambered to cool; on the contrary, rails which, on a circular curve, are concave one-half inch at the center are preferred.

13. *Cooling.*—Rails when placed on the hot beds must be spaced at least 8 to 12 inches apart until cool enough to be sent to the straightening presses.

14. *Cold Straightening.*—Cold "gagging" the rails severe enough on the head or base to leave the impression of the "gag" will not be permitted. The distance apart of the supports in the straightening press must be suitable for the stiffness and section of the rail.

For the 65 and 70-pound sections, not less than 36 inches between center to center of supports.

For the 75 and 80-pound sections, not less than 40 inches between center to center of supports.

For the 100-pound section, not less than 44 inches between center to center of supports.

The supports on the straightening presses must be flat, not worn hollow, and set on the press, "out of twist," having recessed fillets in the corners.

The steel "gags" or "fullers" must have rounded, instead of sharp, corners.

The rails must be straight in all directions, as to both surface and line, without twists, waves or kinks, particular attention being given to having the ends without kinks or drops.

No rails shall be straightened until they have cooled so they can be handled with the bare hands.

15. *Finish.*—The rails must be smooth on the heads and bases, and free from all mechanical defects, flaws and seams, and must be sawed square at the ends. The burrs made by the saws must be carefully chipped and filed off, particularly under the head and top of the flange, to ensure proper fit of the splice plates.

16. *Drilling.*—Drilling for bolts to be in strict conformity with the blue print attached, or the dimensions given herewith. Holes imperfectly drilled to be filed to proper dimensions. All holes must be accurate in every respect, and finished without burrs.

17. *Branding.*—The name of the maker, date, year and month, with the designation of the rail, to be rolled on the side of the web.

The number of the heat to be stamped on the side of the web so as not to be covered by the splice plates. The rail from the top of the ingot to be also stamped "A," the second rail "B," the third rail "C," the fourth rail "D," and the fifth rail "E."

18. *Drop Tests.*—One rail butt, at least four and one-half feet long, to be taken from each heat, and placed upon skids, side by side, to cool. The heat number to be stamped upon each. If the heat exceeds nine tons, then two rail butts are to taken if the Inspector so desires.

The butts when cool to be placed, either head or base upwards, or on the side on solid steel or iron supports, and upon them shall be dropped a weight of 2,000 pounds; the height of drop and distance apart of supports for the different weight of rails being as follows:

Weights per yard.	Height of drop.	Distance apart of support.
60	16 feet.	3 feet.
65	16 "	3 "
70	16 "	3 "
75	20 "	3 "
80	20 "	3 "
85	20 "	3 "
90	20 "	3 "
95	20 "	3 "
100	20 "	3 "

Ninety per cent. of such tests must stand without breaking, and broken butts not showing an elongation of four (4) per cent. in the inch under greatest tension, the rails of that heat are to be held until a piece can be cut from one, tested under the drop, and, if it fails to show the four (4) per cent. elongation before breaking, shall subject to rejection the entire lot of rails made from that heat.

19. *Inspection.*—The Inspector representing the purchaser shall have free entry to the works of the manufacturer at all times when

this contract is being filled, to satisfy himself that the rails are being made in accordance with these specifications. The manufacturer shall daily furnish the carbon and manganese determinations of each heat, and a complete chemical analysis of at least one heat of each day and night turn in which each element is to be determined.

20. *Rejection.*—Inspectors shall have power to reject rails made from insufficiently sheared blooms, or from heats, the test butts of which have failed, or from badly poured heats, or from "chilled" heats, or from "bled" ingots.

21. *Handling and Loading the Rails on Cars.*—Care is to be taken n handling the rails during manufacture, so as not to bruise the flanges, or throw or let the rails fall upon each other.

In loading upon the cars they must be skidded into them and not thrown in or allowed to fall from any height.

When rails are loaded on gondola cars with the end boards turned down, so that the ends of the rail rest on them, a wood cleat or blocking must be placed across the middle of the car to support the middle of the rail on a level with the top surface of the turned-down end board.

STANDARD SPECIFICATIONS FOR STEEL A LICE BARS FOR RAIL JOINTS.

1. *Chemical Composition.*

Constituents.	For bars not exceeding $\frac{9}{16}$ inch in thickness.	For bars exceeding $\frac{9}{16}$ inch in thickness.
Carbon	0.25 to 0.30	0.10 to 0.12
Manganese	1.00 to 1.30	1.00 to 1.30
Phosphorus not to exceed.	0.06	0.05

2. *Analyses.*—The determinations by chemical analysis for carbon and manganese shall be furnished for each heat of the steel, and similar determinations for phosphorus and silicon shall be furnished daily.

3. *Ingots.*—All ingots shall be well poured, and made so that they will set quiet on top without "sanding"; and must be of sufficient area on the top end to afford ample metal for at least 50 reductions in area, for the desired section of angle bar.

4. *Test Ingots.*—Test ingots of $2\frac{1}{2}$ by $2\frac{1}{2}$ by 4 inches in size shal be cast from each heat, which shall be rolled into test bars of one-half ($\frac{1}{2}$) inch square, and be cut into pieces of eighteen (18) to twenty (20) inches in length, which pieces must bend to a right angle without breaking; but any form of bar not less than one-half ($\frac{1}{2}$) inch in thickness or width will be accepted, which, when bent to an angle of from 90 to 160 degrees shows a "stretch" of the metal on the outside of the bend equal to about twelve (12) per cent. per lineal inch.

The bars must be rolled, and the bending be done by blows of a sledge hammer.

5. *Heating.*—The steel, either in ingots or blooms, must not be overheated to such degree as to cause the cinder to run when drawn from the furnace.

6. *Rolling.*—The angle bars must be rolled to shape in strict conformity with standard templates which shall be made for each of the several sizes and sections of bars required, from the dimensions shown in drawings or blue-prints of same, which will be furnished by the railroad company; particular attention will be required that the height of the bars, as determined by the fishing angle, is also at the proper distance from the center line of the rail section, as shown by the standard drawings of same furnished by the railroad company—as the proper fit of the bars to the rails depends on this feature, its strict observance will be insisted upon. The bars must be rolled with a smooth surface finish and be free from fins or cracks on the edges.

Before cutting up into splice-bar lengths the hot bars must be run upon proper hot beds, and be held in proper position to insure cooling as uniformly as possible.

7. *Branding.*—The name or initials of the maker, and date and year of rolling, also the designation of the particular rail section to which they apply, as per the standard drawings, are to be rolled upon the bevel of each bar, in such position as not to be under the heads or nuts of the bolts. Bars branded on the center line of the punching will be rejected absolutely.

8. *Shearing.*—The knives of the shears must be well and properly shaped, and at all times kept sharp and must shear clean, without tearing, cracking or leaving "fins" on the bars.

9. *Punching.*—In all bars the entire six (6) holes must be punched at one operation; and so as not to cause "swelling" in the edges of either of the fishing angles, and must be punched clean and smooth, leaving no cracks or burrs.

The punches must be set accurately in line and center-spaced in strict conformity with the standard templates made from the drawings furnished by the railroad company. The punches and dies must at all times be kept sharp and in good order.

Punching one hole at a time is absolutely prohibited, and plates so punched will be rejected.

10. *Notching.*—All the spike "notches" in any one bar must be punched at one operation, and must strictly conform, both in size and shape, with the dimensions shown on the standard drawings of the same.

11. *Inspection.*—All bars must be straight and free from kinks in any direction.

The Inspector representing the railroad company must compare all "cold templates" and gages to see that they are in strict conformity with the dimensions given by the standard drawings for any section; and any template or gage not so conforming must be re-adjusted or replaced; and any heat of steel or splice bar found by him not to be in conformity with every requirement of this specification shall be rejected by the said Inspector.

The Maintenance of Iron and Wooden Underframes of Freight Cars in France.

BY M. L. TOLMAR,
GRADUATE OF L'ECOLE POLYTECHNIQUE,
CHIEF OF THE SHOPS OF THE EASTERN RAILROAD OF FRANCE
AT MOHON (ARDENNES).

The railroads of Continental Europe possess a great variety of rolling stock, many of which are to be seen not only in passing from one country to another but even on the railroads under the same administration. In excepting the passenger coaches and the accessory cars for fast schedules (luggage vans, cars for equipages, for stabling, etc.) as well as the special cars such as refrigerator, tank, etc., there remain in France about 250,000 cars, the maintenance of which will be the subject of this article. Nearly all these cars present the following features:

1st. The frames rest directly on the wheels without the intermediary of bogies or trucks. They have in general two pairs of wheels, about one meter (39.4 inches) in diameter, and these support the weight through the medium of half-elliptic springs.

2d. Their lengths vary between 4.5 meters (14.8 feet.) and 8 meters (26.2 feet), and their carrying capacity is 10,000 kilograms (22,000 pounds), while the weight is between 6,000 and 9,000 kilogrammes* (13,200 pounds to 19,800 pounds).

3d. Their draw-gears have either spiral or high-elliptic springs.

None of these cars have continuous brakes, but about one-tenth of them are furnished with hand-brakes.

CLASSIFICATION.

From the standpoint of the materials employed in the construction this rolling stock may be classed in three groups:

1st. Cars with wooden underframes.

2d. Cars with mixed underframes (longitudinal sills of iron and transverse members of wood).

3d. Cars with iron frames.

We will mention that frames of wood reinforced by iron plates are in use, but their numbers are few. The Eastern Railroad has only applied these plates to permit the use of the Westinghouse air-brake on some old passenger coaches with wooden frames. Four hundred flat cars have likewise been supplied with iron plates for reinforcing the sills at the middle of their length.

Each of the groups enumerated above includes cars of several types, which can be divided into three principal ones:

a. Flat cars.

b. Open cars with high sides, with or without doors, for the transportation of coal, coke, minerals, etc.

c. Closed cars.

Taking as a basis the rolling stock of the Eastern Railroad, we can establish the following table, from which we can obtain an approximate idea of the general division of the rolling stock of France in the preceding classification.

Designation of groups.	Flat cars.	Open cars with high sides.	Closed cars.	Totals.
Cars with wooden frames	3,212	3,632	2,903	9,747
Cars with mixed frames	614	2,685	1,198	4,497
Cars with metal frames	5,205	3,898	6,334	15,437
Totals	9,031	10,215	10,435	29,681

GENERAL DESCRIPTION AND MAINTENANCE OF THE GENERAL TYPES.

Running Gear, Draw Gear and Brakes.—The progress realized in the lubrication of journals and the construction of wheels, the different requirements that the administrations are obliged to meet to facilitate the exchange of cars, often compel them to modify various parts of the running gear and draft gear. The expense involved in these changes is often confounded with the cost of maintenance, properly so called. There is little of interest in this question, which is after all outside of the limits of the present work; the same may be said of brakes.

Boxes.—The boxes entirely of wood appear to be abandoned more and more for the new rolling stock with high sides, as this

* At present new cars are constructed to carry 15,000 kilogrammes (33,000 pounds). Several companies are adopting cars of 20,000 kilogrammes (44,000 pounds) capacity.

class of rolling stock is subjected to severe usage, being often loaded from wagons whose contents are dumped into the cars from a considerable height.

The first attempt to use iron upper frames (that is, frames for holding the sides and ends) were not very successful, the sections being generally too light. At last to obtain boxes of light weight and small cost they sacrificed solidity and facility of repair. Oxidation, together with the wear of service, have prevented them from being more durable than the boxes made entirely of wood.

To-day, at the risk of increasing the dead weight, they have adopted stronger sections, of which one can judge by examination of those represented in Fig. 1. It would be difficult to say in advance what ratio there will be between the durability of the first and of the last types, but we can without hesitation admit that the advantage will be with the new sections.

The repairs necessitated in running service are almost always from accidental causes and consist in uprights or moldings (upper bands) worn or broken. It is not usually economy to repair these parts—they are simply replaced by new pieces prepared in advance. This work is facilitated in many cases by having the pieces secured by bolts* and not with rivets, so that there is no difficulty in substituting one piece for another.

Boxes entirely of iron are, with the French companies, used only in exceptional cases. The Belgium and German roads are abundantly supplied with them. The running repairs of such boxes are certainly less than boxes whose sheathing is of wood, until the time when it is necessary to replace the sheathing or repair the under parts weakened by rust, which collects rapidly. In case of serious damage resulting from a collision or derailment, the repairs afterward are very expensive. We have found a number of times that the cost of such repairs has been more than 25 per cent. of the purchase price, while that for cars with wooden ends and sides (upperframes of iron or of wood) under the same conditions would not have reached 10 per cent. This work of repair requires a very complete set of tools and a staff of skilled workmen, such as iron workers—seldom found except in shops of considerable importance.

Several administrations such as the Eastern and Northern railroads have kept in their equipment some covered cars with boxes entirely of wood. These cars do not have to resist as heavy strains as do the open cars with high sides which transport full loads of heavy material; the use of iron sections for the upperframes is thus less needful, and when we arrive at this condition, we may remain content with light sections. As in the case of the uncovered boxes, it is difficult to give an opinion of the advantages of wooden upperframes over the iron ones, or vice versa. In discussing it, we find that it raises very complex questions relating to the kind of traffic, the circumstances under which one finds himself, the traditions of the owning administration, etc. We do not believe it possible to reach an actual conclusion in such a discussion.

We give further on a series of designs representing cars of which the boxes belong to the different types of which we have spoken.

Underframes.—Although the cost of an underframe is only one-tenth of the total cost of a car, this part is to be considered the most important. It is admitted that the duration of the frame is the same as that of the car itself, and that the repairs it requires correspond almost always to the repairs of the box.

The frame is far from being subjected to the complex conditions which govern the establishment of a type of car; it is simply required to be of small cost, substantial and easily maintained. For this reason each grand administration limits itself to a small number of types of frames, while admitting a very great diversity of types of boxes.

The question of knowing if it is preferable to construct the underframes of wood or to introduce steel sections presents itself with a special distinctness that makes it interesting to examine.

The frames of wood are almost always of the rectangular outline (Fig. 2) *A B C D*, braced here and there by intermediate transverse members, and rendered rigid by diagonal bracing. These various pieces made of oak are joined by means of gussets, knees or brackets, and iron plates, and the guard plates (pedestal jaws) are fastened directly on the sills.

As a rule these frames deteriorate continually in consequence of the working of the joints and the shrinkage and checking of the wood, and finally by the decay at the mortises and tenons and the different holes for bolts, screws and hook bolts. As a result of unusually severe pulling and buffing shocks the transverse members break and finally the diagonal bracing and the sills fracture. When these last resist the shocks, they finally become considerably bent and drop so much at the ends as to lower the buffer below the required height and to interfere with the working of the doors. If the repairs are frequent they have the advantage of being easily made by very ordinary carpenters who can be found anywhere. About 30 years ago the proportion of carpenters in the shops was greater in comparison with workmen of other trades than is the case to-day.

The mixed underframes (Fig. 3) differ from the wooden frames only in the adoption of iron sills of *I* section. The running repairs of these frames can be made with the same facility as the wooden frames except, of course, when the iron sills are affected in consequence of serious accident.

The frames, entirely of iron, are usually made upon one of two different types.

One of these (Fig. 4) exactly reproduces the form of the wooden frame, the parts being replaced by metallic pieces. The adoption of channel iron sections in the rolling stock of the Paris-Lyons-Mediterranean Railroad facilitates the attachment of the pedestal plates, which may be made of plate-iron simply cut out to the form required (Fig. 5); besides the intermediate transverse members can be replaced without it being necessary to separate the box from the frame.

The other type (Fig. 6) is designed on entirely different lines from the wooden frames. The diagonal bracing is done away with, and the rigidity of the frame is obtained by corner gussets *A, B, C, D* and by a sufficient number of intermediate transverse members of a larger section than in the preceding case. This type, which is the principal one of the Eastern Railroad of France, employs I-beams for the sills, has greater rigidity than the preceding design, but does not permit the intermediate transverse members to be so easily replaced. On the other hand, it is better adapted to be machine-riveted, and this gives it greater durability. The floor-stringers, *F F, G G*, give solidity to the system and serve to sustain the flooring. Those placed near the longitudinal axis of the frame receive directly the strains from the draw-gear and transmit them to the frame.

The type of frames represented in Fig. 7 does not lack interest, for it partakes of the nature of both of the preceding types: it is this type which seems to us to give the best resistance in case of collision.

Contrary to the experience with wooden or mixed frames, the iron frames are affected but very slowly by oxidation that endangers their solidity.* We have never been able to prove, even in shops where about 30,000 cars a year are repaired, that damage to the frames was attributable to the disappearance of rivets or the premature weakening of the sections by rust.

A fear of the consequences of the breaking of rivets is, nevertheless, often expressed by persons, who base their opinions on that which takes place with metallic bridges. There is in reality no comparison between the joining of parts belonging to a bridge and those of car frames. In the case of a bridge the rivets of the bracing connecting the beams evidently work scissor fashion as these braces take the rolling loads; in the case of the car frame the load is principally on the sills, themselves forming beams, and the bracing serves chiefly to maintain the spacing of said sills, thus giving the rivets very little strain of the scissor kind. The damages produced are principally to the iron sections of which the frame is composed.

* The use of rivets is frequently insisted upon by the customs to avoid the too easy taking apart of the box, thus permitting fraud.

* See article published by the "Revue Generale des Chemins de Fer," of which the translation was published in this journal for August, 1896, under the title of "The Preservation, Maintenance and Probable Durability of Rolling Stock with Metal Underframes and Metal Upperframes."

THE MAINTENANCE OF WOODEN AND IRON FRAMES OF FREIGHT CARS IN FRANCE.

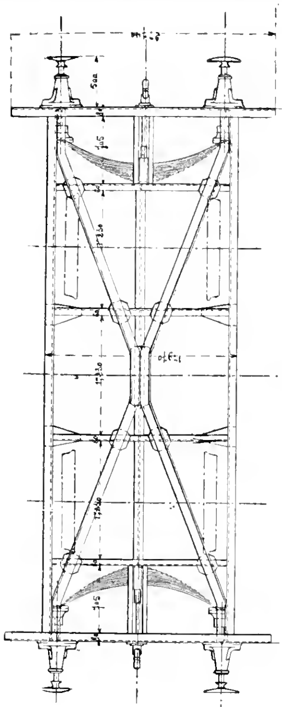


Fig. 4.—Iron Frame.—Paris-Lyons-Mediterranean Railroad.

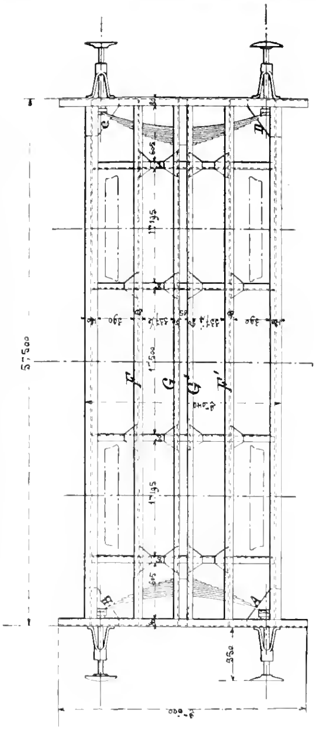


Fig. 6.—Iron Frame.—Eastern Railroad.

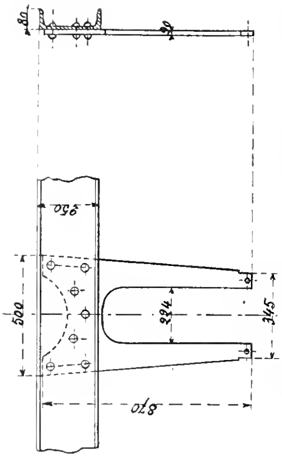


Fig. 5.—Pedestal Plate.—Paris-Lyons-Mediterranean Railroad.

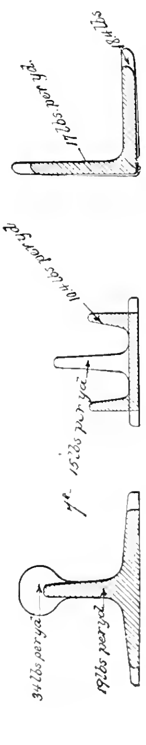


Fig. 1.—Comparison of the Old and New Sections Used in the Construction of Upper Frames.—Eastern Railroad.

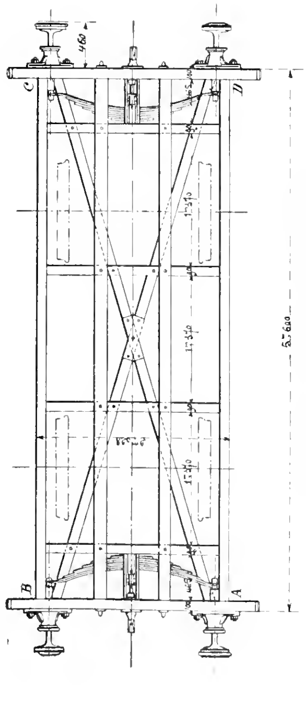


Fig. 2.—Wooden Frame.—Eastern Railroad.

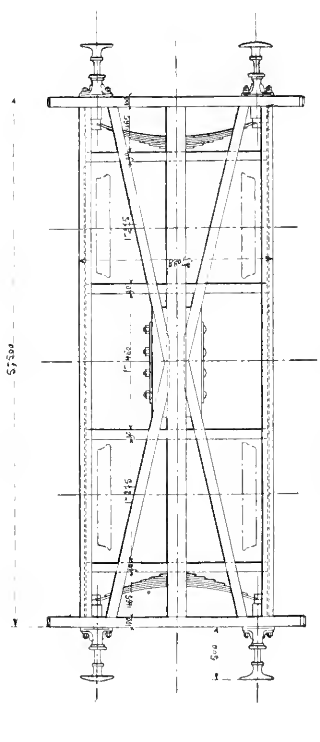


Fig. 3.—Mixed Frame.—Eastern Railroad.

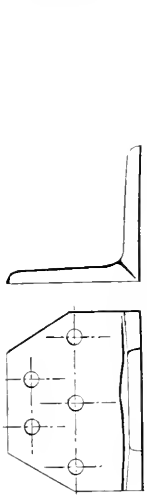


Fig 9.—Fracture in the Corner Irons or Brackets between the Sills and Transverse Members.

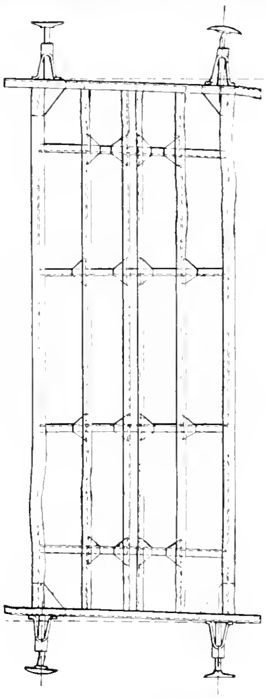


Fig. 10.—Diagram Showing the Deformations of Iron Frames on the Eastern Railroad as the Result of Collision.

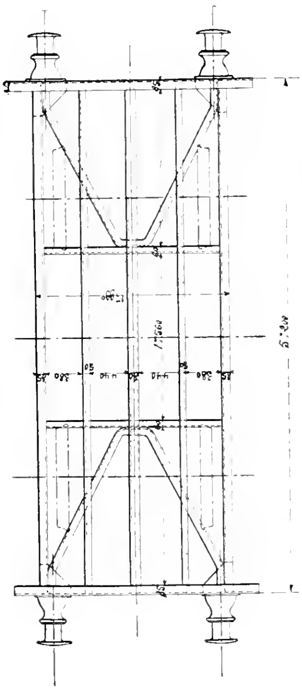


Fig. 7.—Iron Frame Used by One of the Lines Absorbed by the Eastern Railroad.

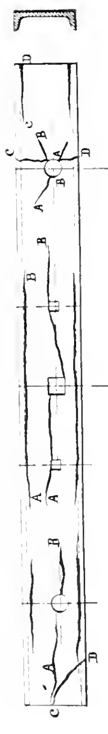


Fig. 8.—Fractures in the End Sills of Iron Cars, Eastern Railroad.

NOTE.—Center hole is for drawhead, adjacent holes for safety chains, and outer holes for buffers.

We have seen some end sills split along lines such as *A B* (Fig. 8) in consequence of abrupt starting or stopping of trains, but these fractures occurred in the earlier sills made of iron and not of the late steel sills; furthermore, the rolling of the iron had been badly done, there being open seams where the iron had failed to weld, which opened up under the shocks of service. Other damages, such as *C D*, and they are the most frequent, are produced in switching—it may be on a bad private crossing or against a platform buffer.

Some corner brackets joining the transverse members to the sills have been found broken at the angle (Fig. 9). The damage was of little importance, and was attributed to the fact that the iron corners presented defects of rolling that would not have existed with steel, which alone is used to-day.

All other damages to the frames proper (deductions made for accessories, such as steps, hooks for switching at stations by means of horses, etc.,) have been the result of exceptional accidents—collisions, derailments, fires, etc.

It is noticed that in collisions the cars of wood placed in between cars of iron are often entirely destroyed while the others have suffered only insignificant damages. In case of collision the deformation of the frame, especially the new ones, are almost always of the same character—the joints resist, the members are more or less bent or broken, but continue to cross each other at right angles. (Fig. 10.)

The repairs are made by taking the entire system of framework apart and straightening the irons, repairing or replacing those which are broken, then putting the frame together again, usually with the same gussets, corner brackets, etc. Replacing sections presenting a slight crack is generally the most economical procedure, but it occasionally happens that it is preferable to patch the damaged part, as, for example, when the section is special and not readily purchased in the market. The straightening of twisted irons has always been done with heat in our shops. Formerly they used a fire (often of wood) on a forge, but now we use gas burners receiving a proper mixture of air and coal gas, which permits us to heat the section at a desired point without having then to manœuver to get it to a press, and, sometimes even without having to take the frame apart. This method, which was recently adopted in our shops, will probably permit the greater part of the repairs to be made by very ordinary workmen, and a limited amount of apparatus of the cheapest kind.

At present these works require fitters, blacksmiths and riveters pretty well trained, and which can only be found in shops of importance. The French railroad companies have shops equipped for the rolling stock only, in which from 300 to 400 workmen are employed and who are at times occupied in constructing new cars when the repairs do not keep them busy.

In those shops where they do in general the work required on passengers cars, the proportion of ironworkers is much larger than formerly and conforms nearly to the following list:

100 ironworkers.
50 operators of machine tools (for ironworking).
50 carpenters or joiners.
20 operators of woodworking machine tools.
30 painters, upholsterers and glaziers.
20 blacksmiths.
30 blacksmiths' helpers.
50 expert workmen: toolmakers, mechanicians, cabinetmakers, etc.

350 total.

With the exception of the blacksmiths and the expert workmen, which are sometimes difficult to find, and who are paid about 30 per cent. higher wages, all the others can be easily obtained in any industrial community. The daily wages in France (provinces, is from four to six francs (80c. to $1.20) for 10 hours' work.

(*To be continued.*)

The Philadelphia Ledger of Feb. 15 prints a dispatch from Pittsburgh, which says that British makers of iron and steel products are alarmed by the invasion of their home markets by American manufacturers. It is stated that tin-plate bars have been exported to the Welsh tinned plate mills for several months, and that some of the tinned plates imported recently were made out of American steel. Bessemer steel billets have been exported, and one Pittsburgh firm is reported to have been recently shipping on an order for 20,000 tons of billets, which have been landed on the west coast of England, at a price of 12 shillings below the local price. Other forms of iron and steel exported extensively are hardware, mechanical tools and various forms of machinery.

Notes From Work Done on the Chicago & Northwestern Locomotive Testing Plant.*

BY E. M. HERR.

The locomotive testing plant installed in the Chicago shops of the C. & N. W. Ry., under the direction of Mr. Robert Quayle, Superintendent of Motive Power and Machinery, consists briefly of three pair of flangeless supporting wheels, 51 inches in diameter, mounted on eight-inch axles, supported in pillow blocks, with 8 by 6-inch bearings, the axles extending through the bearings far enough to receive on each end a cast-iron flangeless chilled face brake wheel 33 inches in diameter, enclosed in a sheet-iron tank. A steel brake band encircles each brake wheel, under which cast-iron brakeshoes are placed. These brakeshoes are drawn against the wheel by tightening the brake band by means of a lever actuated by an air cylinder securely bolted to the pillow block frame. Water is admitted at the bottom of each brake wheel tank and overflows near the top, so that the brake wheel is always immersed in flowing water. The locomotive to be tested is placed upon the supporting wheels with one driver exactly on top of each of these wheels (only two pairs being used for four coupled engines), which are first adjusted to the wheel base of the engine by moving the pillow blocks as required on bed plates, which are securely bolted to a heavy timber foundation. The locomotive is then securely connected by means of an adjustable drawbar to a post amply braced and secured to resist the heaviest strains that the tractive power of the locomotive can exert. Provision is made for supplying and at the same time measuring accurately the fuel and water used while the engine is working under any required speed and power. The smoke and gases from the stack are carried outside the building in which this plant is located by means of a large uptake provided for this purpose. The speed of the locomotive is controlled entirely with the brakes operating on the brake wheels mentioned above. This is done automatically by attaching an ordinary ball governor to the pipe carrying the compressed air to the brake cylinders. This governor is belted to one of the supporting axles, and is provided with a series of pulleys of graduated sizes, arranged to give any required speed from 10 up to 60 miles an hour by admitting compressed air to the brake cylinders only when the required speed is reached, thus applying the brakes and making it impossible for the engine to exceed this speed. The heat generated by the friction of the brakeshoes on the wheels is carried off by the water in which these wheels are immersed, which at the same time serves, to a certain extent, as a lubricant between the brake wheel and shoes, thus keeping the friction more constant than would otherwise be possible. A "Boyer" speed recorder, also belted to the axle, indicates and records the speed. "Bristol" continuous recording gages, continuous and other revolution counters, calorimeters, indicator piping and pantagraph reducing motion are provided and used as necessity or occasion requires. This plant was originally installed primarily for the purpose of breaking in engines just out of the shops, and only secondarily as a device for testing their performance and efficiency. The latter use has been found so valuable, however, that most of the work done on the plant has been experimental.

The results obtained in breaking in locomotives for road service on this plant have not been as uniformly good as could be desired. There is no difficulty in breaking in the driving box bearings themselves and the rods and pins with entire success, but owing to the uniform position in which the engine stands while running it is not possible to have the bearing surfaces on all driving wheel hubs worn down to a perfect bearing. We have found in locomotives broken in on this plant that while all eccentrics, crank pins and other rod bearings, links, rockers, and in fact all bearings, except ing driving boxes, run perfectly smooth, the latter often do not, which is probably to be attributed to heat from the hubs, as the bearings which give trouble on the road ran as cool on the plant as the others. It is on this account as well as from the fact that so much important experimental work has developed that the plant is now being used almost entirely for testing.

It is my purpose to give a brief account of the most important work which has been done on this testing plant since its installation, about eighteen months ago. The first work undertaken was an investigation of the effect upon the performance of C. & N. W. engine No. 19, a 17 by 24-inch engine, with 16 square feet of grate surface and 975 square feet of heating surface, of different amounts of inside clearance in the valve. Fifteen tests were made, at speeds between 25 and 45 miles per hour, and at about six, seven and nine inches cut-off. The inside clearance varied in these tests from zero to 5-16 inch clearance. Each test was run from two and a half to three hours continuously, and at rates of combustion ranging from 62 to 135 pounds of coal per square foot of grate per hour. Incidentally four different kinds of Illinois and Indiana coal were tested. The evaporation of the Indian coal at rates of from 62 to 65 pounds per square foot of grate per hour, from and at 212 degrees, varied from 8.25 to 9 pounds water per pound of coal. Illinois coal varied from 7.5 to 8 pounds, with rates of combustion of from 68 to 90 pounds per square foot of grate. At higher rates of combustion the efficiency of evaporation decreased quite rapidly, with a slightly inferior grade of Illinois coal, being as low as 6 pounds of water per pound of coal, when the rate of combustion was from 125 to 135 pounds per square foot of grate per hour as shown in Fig. 1.

The coal per horse-power hour varied with the power developed, being least for low horse-power, about 250, and greatest for powers above 450 horse-power. The entire range lay between the extremes of 3.55 and 4.61 pounds of coal per horse-power per hour. The highest power developed was 477 at 43 miles per hour and seven inches cut-off. This was easily maintained for two and a half hours and was by no means the limit of the power of the engine. The effect of inside clearance upon the shape and area of the indicator cards at a speed of about 150 revolutions, or 30 miles per hour, is shown by cards not reproduced. With the exception of one end of two cards, which are considered rather anomalous, there is almost no variation in mean effective pressure with a gradual cutting out of the inside clearance of the valve from line and line to $\frac{5}{16}$-inch clearance on each side at this speed and cut-off. What is lost by the earlier exhaust is gained by the later compression. The efficiency of the engine in water per horse-power per hour also shows very little if any loss, it being from 25.5 to 26.5 pounds water per horse-power per hour.

These tests were supplemented by a series of 21 others with engine No. 567, another 17 by 24-inch engine, with a slightly larger grate, 17.5 square feet and the same amount of heating surface as engine No. 19, viz., 975 square feet. They were undertaken with a somewhat wider range of speed, viz., from 16 to 46 miles per hour They confirmed the results of the former series at the higher speeds, but at the lower speeds both the economy and power of the engine decreased when the valves were given inside clearance. Fig. 2 shows the performance in this series of tests.

Still another series of four tests were made on engine No. 797, a 19 by 24-inch ten-wheel engine, with 26.9 square feet of grate and 1,545 square feet of heating surface. These tests were run at speeds of 16 and 35 miles per hour, with 3-32-inch inside clearance and line and line valves. Here the line and line valve showed the greatest at 16 miles per hour and about the same at 35 miles per hour, while the efficiencies were the reverse. These tests owing to some errors in observations are unreliable as data on locomotive performance, but they brought out a very important point in locomotive design, not often fully appreciated. I refer to the importance of stiff and rigid eccentric rods. Engine No. 797 had long, crooked eccentric rods, such as are usually found on 10-wheel engines, and of about the ordinary stiffness. It was found, however, that these rods sprung so much and so irregularly as to make it almost impossible to obtain duplicate indicator cards with absolutely no change in conditions. A decided improvement has been made by making the rods "I" section and this is now being done on all engines passing through the shops for repairs. The evaporating performance in these tests is given in Fig. 2.)

As a result of these tests, checked by as careful comparative records of actual road performance as could be obtained, the following practice has been adopted on standard valves:

For through high-speed passenger service..........	$\frac{1}{8}$-inch inside clearance
" local passenger service..........................	$\frac{3}{32}$-inch " "
" suburban passenger freight and switching....0	" "

The valves of the passenger engines have also longer outside laps than those of the freight and switch services.

The next work undertaken was a test of the effect of a smoke burner on the boiler efficiency of engine No. 597. The tests showed that the prevention of smoke with steam jets in the firebox as arranged on this engine reduced the evaporation per pound of coal.

A feed water heater was tested on this same engine, but no advantage in economy was found by its use in several careful tests. The water per horse-power hour and the evaporation per pound of coal within the errors of observation were almost absolutely identical with the results obtained with the engine run in exactly the same way before the heater was attached. This, of course, only proves

* From a paper before the Western Railway Club.

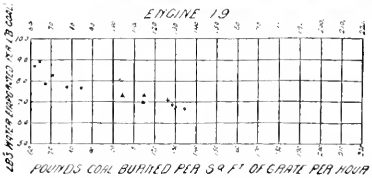


Fig. 1

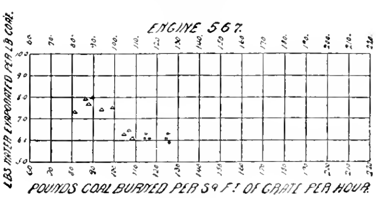


Fig. 2

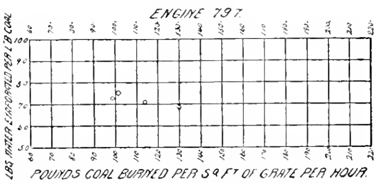


Fig. 3

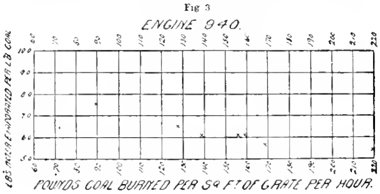


Fig. 4

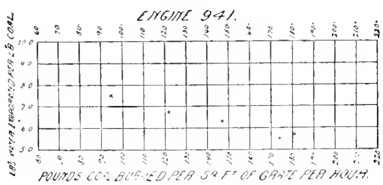


Fig. 5

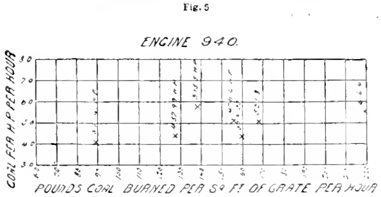


Fig. 6

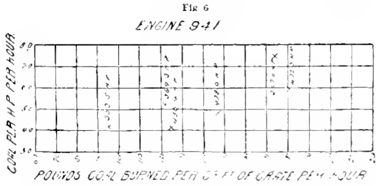


Fig. 7

that the particular heater tested was of no measurable advantage, or in other words, it did not actually heat the water appreciably. Some other design might show different results.

In the tests on exhaust pipes for the Master Mechanics Association upwards of 490 test runs were made, each necessitating 46 separate observations, making a total of nearly 23,000 observations. Of this number there were 367 complete recorded tests, comprising 16,882 separate observations. The others were run while adjusting the apparatus or else they wese defective in some particular and were therefore discarded.

The effect of different amounts of lead on the economy and smoothness of operation was tested on engine No. 901, a 19 by 24-inch eight-wheel engine, carrying a steam pressure of 190 pounds. This engine has 20-inch ports and Allen valves, and it was found that improved results were obtained by reducing the lead from 1/4 inch to 5/32-inch at 6-inch point of cut-off, while no worse performance as far as power is concerned was shown with 1/8-inch lead at 6-inch cut-off with much smoother working. If the eccentrics are both set so as to give 5/32-inch lead at 6-inch cut-off, the full gear lead with the length of eccentric rod used is nearly 3/32-inch negative. That is, the valves at full stroke are blind by this amount. Careful tests indicate that the engine is more powerful in starting with valves blind to this extent than with a lead at full stroke up to 1/16 inch. It seems probable, however, that about 1/8-inch negative lead at full stroke, and 5/32-inch positive lead at 6-inch cut-off is the best adjustment of the valves for fast passenger service with the valve gear as arranged on this engine.

Even with as stiff a valve gear as was used on engine 901, and it is above the average in this respect, the effect of deficient valve lubrication is very marked. Cards No. 9 and No. 10 were taken without changing anything about the engine except the lubrication of the valves, and they are by no means unusual examples. Without changing anything about the engine except the lubrication, the horse-power of the right cylinder was made to show the same as the other.

A rather complete set of 13 efficiency tests was next made on two 15 by 24-inch engines, Nos. 940 and 941, having 61-inch driving-wheels, 15.7 square feet of grate area and 1,125 square feet of heating surface. These engines are exactly alike in design and construction, and yet one was reported and actually showed results on the performance sheet from month to month which were much inferior to those of the other. The tests were undertaken primarily to discover the defect in the inferior engine and remedy it. The indicator cards from these engines were as nearly identical as possible, and when both engines were tested under the sams conditions their efficiency was found to be the same. The "inferior" engine, however, could with difficulty be made to steam as freely as the other on account of slightly defective front end adjustments. This was remedied, and on a test under service conditions on the road both engines did, as nearly as possible, identical work.

Incidentally while these tests were in progress the effect upon the evaporation efficiency of the boiler of varying the rate of combustion per square foot of grate was determined. In these tests no change whatever was made in the size of the grate, but the work done and consequently the water evaporated was gradually increased until rates of combustion varying from 90 pounds of coal to 180 pounds per square foot of grate area per hour were obtained in both engines, and as high as 219 pounds per square foot of grate per hour in engine No. 940. These results are shown plotted in Figs. 4 and 5. They confirm as well as could be expected under the different conditions the results obtained by Prof. W. F. M. Goss and presented at the September, 1896, meeting of the New York Railroad Club. These curves show a rapid and fairly uniform decrease in efficiency as the rate of combustion is increased. The decrease appears to be not at as rapid a rate after that of 150 pounds per square foot of grate is reached, but to establish the correctness of this indication more data should be obtained. These tests show the results obtained from engine No. 797 in tests above referred to, to confirm the results obtained with the deep box for a shallow firebox boiler. The results of the boiler evaporation at different rates of combustion are shown for engines 19, 567 and 797 respectively in Figs. 1, 2 and 3. The results from both engines Nos. 19 and 567, Figs. 1 and 2, are not as accurate and reliable as those in Figs. 3, 4 and 5 recording results obtained from engines Nos. 797 and 941. The error in the first tests was due to the water used being gaged in a tank of which the cross-section was obtained by calculation. In the tests of engines Nos. 797, 940 and 941 the exact weight of water was taken. The effect upon the total economy of the engine of different rates of combustion is shown by Figs. 5 and 6 giving the coal per horse-power per hour at rates of combustion covered by these tests.

The horse-power developed in each test is marked in figures on the diagram. Comparison of these results with those of the boiler performance only Figs. 4 and 5 is interesting. The abnormally high points on the diagrams are due to a leaky condition of the firebox in those tests.

Analyses of the smokebox gases while these tests were in progress resulted as follows:

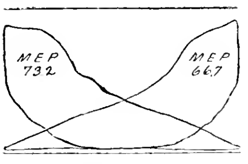
ENGINE NO. 940.

Number of miles per hour.	Length of cut off, inches.	Carbon dioxide, per cent.	Oxygen, per cent.
25	4½	11.1	6.
35	4½	10.8	5.8
45	4½	10.06	8.04
25	7½	11.8	5.4
15	10	10.	7.4

ENGINE NO. 941.

Number of miles per hour.	Length of cut off, inches.	Carbon dioxide, per cent.	Oxygen, per cent.
25	4½	9.03	9.43
35	4½	11 08	6.24
15	10	13.47	2.01

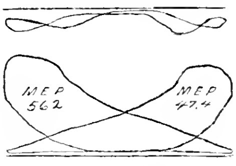
The series of tests above described on engines Nos. 940 and 941 were also utilized to give some data on the effect of long pipe connections for indicators. This subject was exceedingly well presented by Professor Goss at the St. Louis meeting of the American Society of Mechanical Engineers in 1896. The writer confesses that the importance of this matter for lengths of pipe no longer than ordinarily used on locomotives, say three or four feet, was not realized by him until the cards shown herewith were taken, and he wishes to expressly state that all the data based on indicator cards contained in this paper are subject to correction due to pipes 3 feet 8 inches long. Professor Goss has pointed out that it is practically impossible to establish general corrections for long indicator pipes on account of the number of different conditions which modify their effect. It may be possible, however, to establish certain limits of error for known speeds and cut-offs in locomotive cylinders and for the length of indicator pipes usually used which would meet all practical requirements. It is hoped that this important work may soon be undertaken. Cards taken by the same indicator, arranged so that one card was taken through an indicator pipe 3 feet 8 inches long, the other being taken from a pipe about 4 inches long, show the effect of the pipe at various speeds and cut-offs from 82 revolutions to 352 revolutions, and 6-inch and 9-inch cut-off, always to be to increase the area of the card from ½ to 16.9 per cent.



CARD No. 9
Valves well lubricated

Left Cylinder.........6 inches cut off.
Steam pressure..... ....190.
Revolutions per minute, ...168.
Miles per hour.................. 37.5
Horse-power.....................795.
589.

Difference in horse-power....206.



CARD No. 10
Deficient Lubrication.

Right Cylinder.......6 inches cut off.
Steam pressure....... ....190.
Revolutions per minute........168.
Miles per hour.................. 37.5
Horse-power....................589.

Effect of deficient lubrication of valves. Class "A," engine No. 901. Chicago & Northwestern Railway, Sept. 7, 1895.

An interesting series of tests of the tightness of cylinder packing rings was made on engine No. 567 The front steam port of one cylinder was plugged with a steam-tight plug, the front cylinder head was removed and the engine was run at various speeds under full throttle with cast-iron ring packing rings made with different joints, and also with the joint in different parts of the cylinder. The leakage was carefully observed for each condition and recorded. Briefly, the results indicated that the form of the joint was immaterial as long as it was kept near the bottom of the cylinder. The rings when free tend to rotate, sometimes one way, sometimes another, until they find their best bearing, then they seem to remain stationary. When rings are worn to fit cylinder and joints at or near bottom there is no leak with either lap or open joint. New rings put in cylinders only slightly worn leak until they are worn to a bearing. There was no more leakage at speed than when running slowly. The conclusions drawn from the test were that rings should not be free to turn and the joints should always be near the bottom and about 3 to 4 inches apart.

Tests of the efficiencies of two two-cylinder and one four-cylinder compound engines all of different design are now in progress, but still uncompleted.

Fuel Energy Into Electrical Energy.*

BY ELIHU THOMSON.

Notwithstanding the fact that in these days of long-distance transmissions at high voltages the energy of large water-powers will become more available, and also in spite of the fact that the fuel cost constitutes, in many cases, not more than 12 to 15 per cent. of the total cost attending electric distribution from stations, the problem of how to obtain an increased efficiency or a greater percentage of the potential work of a fuel as electric energy, loses none of its interest.

It is certain that if in obtaining any increase of yield the outlay for additional plant, or for more costly plant, or for maintenance and attendance, is such as to give rise to an increased charge of but a moderate percentage over the present costs, there would be a neutralization of benefits. Despite, then, the interest which the working out of any problem naturally has for the scientist and engineer, it remains a fact that any new plan or proposal for increasing the percentage of fuel energy rendered available, must, to be commercial, accomplish its results within such limits of cost and outlay as will depend on the cost of fuel in the particular locality where the plant is to operate.

By the use of triple-compound condensing engines at full load one horse-power hour may be developed at an expenditure of fuel of less than 1½ pounds of coal, a figure which is so low that in any locality where coal can be had for less than $5 per ton places the actual coal cost for full load conditions on a favorable basis as compared with other outlays in the working of an electric plant.

Indeed, the question of uneven loads and peaks in the load becomes then one of far greater commercial importance than saving of fuel alone, when the plant is working at its best, for the great waste of fuel comes in putting boilers into and out of service, while a large engine but lightly loaded is itself a wasteful piece of machinery. Any plan of fuel saving which, while providing for a given output is not flexible, or which does not lend itself easily to a system of storage, might have all its value neutralized in consequence.

Much has been said from time to time concerning the advantages of gas or oil engines as prime movers, and it is certain that their efficiency of conversion may easily rise to 20 per cent. of the energy value of the gas or oil supplied.

Even in quite moderate-sized engines, such as those of 30 horse-power and under, one brake horse-power hour has been produced for less than three-quarters of a pound of anthracite coal made into gas by one or other of the producer methods, while in oil engines of the gas engine type the oil consumption is, even for quite small engines, about one pound per brake horse-power hour.

There is reason to believe that with the work which is being done in improving the engines and producing gas under the most economical conditions, with fair-sized engines, power may be generated on the basis of about one-half pound of coal or oil per brake horse-power, or possibly somewhat better in the case of the oil owing to its relatively high calorific value.

There can be no question about the advantages which such fuel engines have in not requiring any consumption of fuel until they are started. Similarly, when stopped, fuel consumption stops. For a given horse-power cutout, however, the gas engines are probably more expensive as to first cost, while they require attention from time to time, as in cleaning, etc., which is not the case ordinarily with steam engines. The attention to boilers required in a steam plant might be offset in part at least by the care of a gas-producing and storing plant.

The many attempts to employ the thermo-electric principle rely upon an indirect conversion, but in this case there are no moving parts and the mechanical energy stage is missing. The heating of junctions of dissimilar metals in a thermo-electric series and the production of currents of electricity thereby seems at first the ideal of simplicity and practicability, but unfortunately, despite many most noteworthy efforts to improve the thermo-electric pile, its efficiency remains very low.

It is doubtful whether a better economy than 1 per cent. of the energy of the fuel, delivered to the outside circuit of the pile, can be attained even with the latest and best constructions. The

*Abstract of an article in the Electrical World.

actual construction and working of the piles themselves as well as their permanency have undergone great improvement in recent years, but there remains the fact that of the total heat conducted from the hot to the cold junctions, but a very small percentage is converted, or convertible perhaps, into electric energy. The pyro-electric generator of Edison would naturally be open to the same serious objection of insignificant yield.

The remaining type of apparatus for effecting the conversion in question is that in which the fuel or carbon is dissolved as is the zinc in a battery cell, while air or some other oxidizing agent acts as a deplorizer.

Many years ago Jablochkoff devised a hot battery in which nitrate of potassium or niter was fused in an iron pot which was made one pole or terminal, and a carbon stick dipped into the fused niter was the other pole. Violent reaction occurred due to the oxygen of the niter attacking in its hot state the carbon piece, while a fitful current of small energy value relatively to the activity of chemical reaction going on was noticed to flow in a circuit from the pot to the carbon.

Recently the battery of Dr. Jacques has commanded considerable attention. It would seem that in this battery there is in fact an actual quiet consumption of carbon without real combustion. The bath of melted sodium hydrate contained in an iron cylinder has bubbles of air passed up through it from which oxygen is taken up. The carbon rod immersed in the soda bath is gradually oxidized and a current obtained which leaves the carbon in the bath to go to the iron containing vessel and through an outside circuit from the iron to the carbon. It is claimed that as high as 85 per cent. of the energy represented by the solid carbon is thus converted into electrical energy available for use. There are of course difficulties, and perhaps the chief one is the carbonating of the sodium hydrate. Unless a bath can be found which does not form carbonate, and which therefore permits the free escape of carbonic acid gas, this difficulty might indeed be fatal. The handling of fused alkalies is not as easy as might be desired, and the renewal of carbons in battery cells is of course an objection, while the contacts to be provided for large currents passing from cell to cell through hundreds of cells appear indeed formidable. The Jacques battery also will require specially pure fuel molded carbons so as to be of proper form and a good conductor of electricity.

In view of all this the Central Station Manager need not, for the present at least, fear having to throw aside his boilers and engines. The smoothing out of the hills and hollows in the load diagram is apparently of more real importance in his case than systems which would double or treble the present coal efficiency, by which is meant the percentage of energy value of the fuel converted into electric current energy.

Operating Belleville Boilers on British Cruisers.

In an editorial on the excellent trials of the new British cruisers *Powerful* and *Terrible*, the *Engineer* gives the following interesting description of the methods employed in the fire-room, where 48 Belleville water-tube boilers furnish the steam, which suggests that much auxiliary apparatus and skilled labor are required:

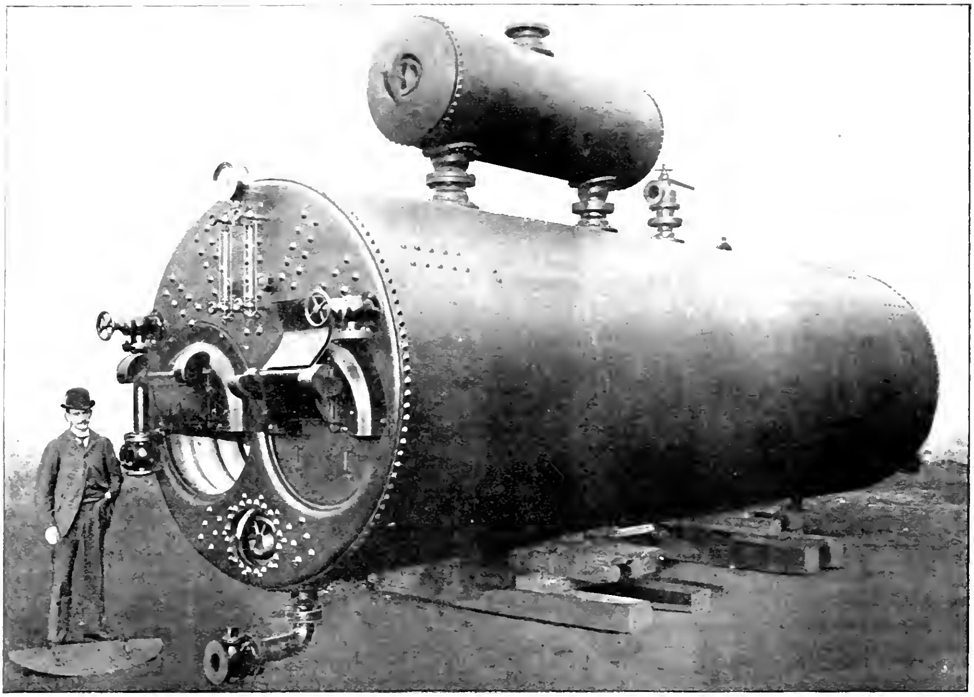
"Instead of the rough-and-ready way with which most of us are familiar, steam was made on these ships with a scientific refinement of manipulation the like of which has probably never been seen before. The Belleville steam generator is not, in the proper sense of the word, a 'boiler' at all. It is a very peculiar and special piece of apparatus; none the worse for that, however. But it must be treated in a special way, and its peculiarities must be thoroughly understood. It has been said by a very competent authority that it has no circulation in the ordinary sense of the word, and that is, we think, true; but it has certainly an efficient substitute for circulation. Again, in most boilers it has been found sufficient to admit air, or blow it in, above the fire to keep down smoke, but something more than this is needed with the Belleville generator; and so we find a number of cunningly devised air compressors, dispersed in the boiler-rooms, which supply divers small jets, and so throw streams of air into corners and out-of-the-way places among the tubes, and so there is flame produced where, without these jets, there would be smoke and a heavy deposit of soot. Furthermore, as the Belleville boiler will by no means tolerate bad stoking, a special system of firing has been devised. In each fire-room is a clock with a peculiar dial, and by its aid fires are fed with the regularity of machinery, and with a discrimination which no machine can pretend to manifest. Like everything else, the feed pumps have been specially designed, and the regulation of the feed is all but entirely automatic.

"When we speak of the success of the Belleville boiler, we must remember that the boiler could not have been worked to advantage, if at all, but for the skill and care displayed by those who had been intelligently educated in its use. The ordinary boiler is compared with the Belleville generator, as a kitchen clock is to a chronometer. When we hear, as we do now and then, of the failure of such boilers, it will, in future be safe to say that the failure has been due not to the generator, but to the way in which it was used. The greatest credit is due to Mr. Durston and his staff for the way in which they have recognized and seized on the point which are vital, and for the skill with which a small army of stokers has been trained to do exactly what was wanted with the precision of clock-work. It is no disparagement to the generator if we say that we do not think that outside her Majesty's Navy, it would be possible to find so splendidly disciplined a fire-room crew. We venture to think that Mr. Durston will be among the first to admit that everything depends on the way in which the generator is managed—in a word, on the way in which the details of the new process of steam-making are carried out; and we not unnaturally ask, What would happen if the exigencies of warfare should leave such ships as the *Terrible* with a crew of stokers quite untrained in the new method of steam making? We have no doubt but that for some years to come the Belleville generator will have it all its own way in the Navy. We trust it will not be introduced faster than men are trained in its use; and, indeed, it seems to us to be desirable that the two new ships should be kept in commission for no other purpose than to pass stokers through them as training ships. We believe that fixed boilers on land are intended to be used for this purpose."

A Test of Petroleum Fuel.

In a recent issue of the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale* particulars are given on some experiments with oil firing for boilers made by Messrs. Weyler & Richmond. The first experiments were made on a boiler apparently of a modified Cornish type which formed one of a pair. Its fellow was fired by coal, and served as a means of comparison. Each of these boilers had 393 square feet of heating surface, of which 226 feet was internal heating surface, furnace tubes, etc., and the remainder external. The capacity of each was 157 cubic feet, of which 122 cubic feet were water space. The oil used was a heavy American oil, having a specific gravity of .910. On its way to the burner it passed through a water jacket, in which its temperature wass raised to 100 degrees or 120 degrees Fahr. The burner was arranged to spray the oil by means of a jet of slightly superheated steam from the second boiler. The spray thus produced formed a large flame on issuing from the burner, and was deflected by a special shield so as to throw it down on to the grate, which for the purpose of the experiments was, with the rest of the furnace, lined with firebrick. Through the portion covering the grate there were air openings, which were inclined upward and away from the jet. The number and size of these openings were varied several times before the best results were obtained. The first observations were directed towards ascertaining the time required to raise steam. The best time made was 1¼ hours, the comparative slowness being attributed to the large amount of heat absorbed by the furnace lining. The best evaporative efficiency was 12.6 pounds of steam, evaporated at a pressure of 85 pounds per pound of fuel employed, equivalent to about 13 pounds of steam from and at 212 degrees Fahr. It was found that about 400 cubic feet of air were required per pound of oil burnt, and that the orifices in the grate should be proportioned so as to give this air a velocity through them of from 15 feet to 21 feet per second. Further experiments on a small semi-portable engine generating 10 horse-power and working at a pressure of 98 pounds per square inch, showed a consumption of 3.94 pounds of oil per horse-power per hour.—*Engineering.*

President Fish, of the Illinois Central Railroad, is said to have proposed a plan for government control of the Pacific railroads, which contemplates the taking by the Government of both the Union and Central Pacific roads, and making of them a public highway from the Missouri to the Pacific, giving all connecting roads equal rights thereon. This could be accomplished either by the Government's maintaining the roadbed and letting every company run its own trains over it or by having government engines to haul all cars that may be offered. It is probable, however, that the Union Pacific will be sold to a satisfactory private bidder.



A Lancashire Boiler with Welded Shell.—Built by the Continental Iron Works.

A Large Lancashire Boiler With Welded Shell—Built by the Continental Iron Works.

The Continental Iron Works, of Brooklyn, N. Y., are well known for the excellence of their boiler work, their ability to turn out flanged plates of the most difficult forms, and for the welded steel shells made by them for various purposes. This welded work is almost essential in the construction of pulp digesters for paper mills, as the changes in temperature to which the digesters are exposed, together with the searching qualities of the soda charges put in them, make it almost impossible to keep riveted joints tight for any length of time. The company has made pulp digesters of various sizes, the largest of which is 7 feet in diameter and 29 feet long. There is not a single riveted joint in these structures, the heads being welded in and the manhole flanges being also welded to the shell.

The corrugated furnaces for marine and land boilers form another class of work in which welding takes the place of riveted joints, and of which the output of this company is very large.

The company has recently turned out a fine piece of work in the shape of a large Lancashire boiler with a welded shell. The boiler, a view of which we give in the accompanying illustration, is 8 feet 6 inches in diameter and 27 feet 3 inches long, and has the largest welded shell that has ever been made in this country, and it is believed to be larger than any built in any other country. The photograph shows it to be a beautiful piece of boiler work.

The boiler is to be set up in Lynchburg, Va. It will carry a working pressure of 125 pounds, and has been tested at 180 pounds. The shell is $\frac{9}{16}$ inches thick and the heads are $\frac{3}{4}$ inches. The furnaces are of the Morison suspension (corrugated) type and are 40 inches in diameter. They extend from end to end of the shell, the appearance of the back end resembling the front one, except for the absence of the fittings. The furnace doors are the Morison patent, secured to pressed steel furnace fronts. These fronts are protected on the inside by perforated cast-iron liners. The Morison door is arranged to open upward, and is counterweighted so as to remain open while the furnace is being stoked. Thus latches and similar devices are avoided. It also is of such a form as to prevent accumulation of fuel on the front end of the grate, and thus prevents the overheating and ultimate destruction of the door and its attachments, besides keeping the boiler-room cooler and making it more comfortable for the men. This fire-door has been adopted by many prominent firms for both marine and land work, and by the United States Navy.

The manhole plates, rings and crabs are of pressed steel, and of the most approved form.

The company's boiler work has been largely for marine purposes, but it is now making internal furnace tubular boilers which possess many advantages, among which are their great economy, the absence of a brick setting, and the ease with which they can be kept clean. These boilers are cylindrical, with corrugated furnaces, and tubes for returning the gases to the uptake at the front end. Several large plants are wholly equipped with boilers of this kind.

It is said that in a few weeks the Bazin roller-boat, which was launched some time ago, will be ready for trials at sea.

"The 4 p. m. Limited" between Boston and New York on the Boston and Albany Railroad has been newly equipped with elegant coaches and drawing-room cars, built by the Pullman Company expressly for this train. All the cars are vestibuled, and it is claimed they excel, in beauty of finish and comfort, any others in New England. A dining-car is attached to the train between Boston and Springfield. Like all passenger trains on this road, the cars are lighted by gas and heated by steam.

Communications.

The Training Which Apprentices Need.

ATHENS, Pa., Feb. 6, 1897.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

In an article under this head in the January number of your journal, the foreman was severely censured for the unsatisfactory working of the present apprentice system. Now let us look at the material we have to work with. The boys are employed around depots and railroad shops because they are cheaper than men and they are taken as young as the law will allow. As an inducement for boys to take such jobs as wiping, errand boys, call boys and the like, they are offered an opportunity to learn a trade. As a rule, the boys that accept these positions are insubordinate; they have either been expelled or will not go to school. Their parents prefer they would loaf around an office or do anything rather than to loaf around the streets.

Now the first thing they learn is to loaf, and when they commence their apprenticeship they must learn to loaf on scientific principles and watch the boss or superintendent. They must have something handy to scrape or hammer when he is around. You can see by this that the foreman has the worst material the town affords to begin with; cheap labor is the first and last object of the companies.

Suppose the applicant for an apprenticeship is required to graduate at the high school or show some good reason for not doing so; some are obliged to get work to support a mother or themselves, but these boys are upright and of good moral character. This class of boys would not be desirable. They would not accept a job of wiping at 40 or 60 cents per day for six months or so for the privilege of serving four years at a trade.

The companies would be obliged to pay from one dollar to one and a quarter for men to do the work that the boys are doing at present, but they would have a better class of apprentices—a class that the foreman would feel some encouragement in teaching and by whom it would be appreciated. The night schools would flourish, the boys would have the rudiments of a technical education, and you could make better workmen of them, for the workmen have degenerated with the apprentices.

In a shop of over 400 men and boys I do not know of one who reads a technical paper of any kind. At present it is impossible for a young man who has graduated to get a situation to learn a trade, for every place is filled a year ahead.

Gentlemen of the Master Mechanics' Association and the Railroads, give us better material, and we will show you what we can do.

A GRADUATE.

Our correspondent is undoubtedly right in urging the selection of better material for apprentices. It is almost impossible to cover all points in discussing a matter of such magnitude as the requirements of a good apprentice system, and in the editorial referred to in this letter we had assumed for the moment that apprentices for whom a technical training such as proposed by the Master Mechanics' committee and others, were of such a character as to profit more or less by such training. The knowledge which such young men seek when they enter the shop is not to be found in a technical education, but in what is commonly known as shop training. This they seldom get as fully as they might, sometimes through the fault of the foremen, but more frequently because of the lack of interest in them by the heads of departments, and the failure to make provision for their proper instruction. We had no intention of dealing severely with the foremen, as they are not responsible for the present condition of affairs, but it is well for them to bear in mind that the part they must play will be a most important one in any successful plan to give apprentices a better training than they now receive.—ED.

Air Compression by a Falling Column of Water.

NEW YORK, Feb. 10, 1897.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

In the current issue of your paper you notice a method of air compression adopted at an installation near Montreal, Can., and refer to it as being a "novel" manner of compressing air. On the ground of belief that most persons might, at first sight, think such a system an entirely new one (judging from your adjective "novel") and feeling that you commendably wish your journal to be a star of the first magnitude in the heaven of exactness, I presume far enough to hint that the use of a column of falling water is by no means new as applied to air compression. If I mistake not, such a plan was in use for blowing air in the very early days of iron working processes under the name of the "Trompe" blower and in numberless laboratories is the principle used with an opposite object in view, *i. e.*, attenuation instead of compression, to expedite filtering operations. An illustrated article on this form of compressor, by G. D. Hiscox, Consulting Engineer, was published in Engineering Record, for Nov. 19, 1892. See also an allusion to it by W. F. Durfee, M. E., in Trans. A. S. M. E., Vol. VII., pp. 804-805. I I have such an arrangement in use in my home for supplying, when wanted, a continuous current of air, operated by a form of injector which I made for the purpose, as I had not the advantage of a column of water.

Of course, I may be all wrong in my understanding of your meaning of the word "novel." If you mean by it "not old" then the foregoing holds good; if "not usual" then I silently back down.

Very respectfully yours,

WM. F. MONAGHAN,
Member A. S. M. E.

[Perhaps it would have been better either to have avoided the use of the word "novel" or to have been less brief and to have explained our use of the word. We were aware of the earlier use of the same method of compressing air mentioned by our correspondent, and in using the word "novel" in our description of the Taylor plant had in mind the fact that it was "not usual," and furthermore that the earlier applications of the method were not made, if our information is correct, with a view of obtaining the high pressures such as obtained in the case cited. It was employed more as a blower, rather than a compressor, as those terms are understood to-day. We trust this explanation will clear away the fog that appears to envelop our allusion to the Taylor compressor.—ED.]

Superheated-Steam Engine Trials.

At a meeting of the Institution of Civil Engineers, in January Prof. Wm. Ripper read a paper on the above subject, and presented in tabulated form the results of many engine trials in which superheated steam was used.

The author pointed out that the limit of possible economies from multiple expansion and high-pressures having been nearly reached renewed attention was being given to superheating. Trials have been carried out on a 17 indicated horse-power Schmidt motor, a single-acting, simple, non-condensing engine, supplied with superheated steam from a Schmidt superheater, to determine the steam consumption of the engine working with various degrees of superheat, and at temperatures beyond those usually employed; and also to find to what extent the dryness fraction of the steam, and the heat exchange between it and the cylinder walls, were affected by the superheat.

The heat expended in superheating reduced the amount of heat employed in evaporation of water; but the heat so diverted for the purpose of superheating was shown to be productive of a considerable gain in thermal efficiency. Thus an expenditure of 5, 10 and 15 per cent. of the furnace heat to superheat gave a net gain of 12, 38 and 70 per cent. respectively of the work done for heat supplied. When the load on the engine was fairly constant, little regulation of the superheat was necessary, and the temperature of the superheated steam in the coils remained remarkably steady. If the load on the engine was reduced, the temperature of the steam in the superheater immediately began to fall, though there was no appreciable change in the condition of the fire; on the other hand, if the load was increased, the temperature of superheat increased also.

The effect of varying degrees of superheat upon the steam consumption per unit of power was illustrated by a large number of trials under varying conditions. Taking one example, it was shown that steam at 120 pounds per square inch pressure superheated to 674 degrees Fahr. on entering engine, reduced the steam consumption from 38.5 pounds without superheat, to 17.05 pounds per indicated horse-power per hour, the rate of decrease of steam consumption with increase of superheat being approximately uniform within certain limits.

It was pointed out from the indicator diagrams how rapidly the superheat disappeared on the admission of the steam to the cylin-

der, and how few were the cases in which the steam in the cylinder was found to be superheated at cut-off, though admitted in a highly superheated condition. It appeared from these experiments that unless the degree of superheat of the steam entering the engine reached at least 200 degrees Fahr. above its normal temperature with a late cut-off, or a still higher degree of superheat for an earlier cut-off, the condition of the steam in the cylinder at cut-off was that of wet steam at the temperature of saturation.

In order that the steam in the cylinder might be superheated during expansion and dry at release, it was necessary that its temperature on entering the engine should be about 300 degrees Fahr. above the temperature normal to its pressure. When the steam was dry at release it was superheated at cut-off from 50 degrees Fahr. to 100 degrees Fahr., finally falling at end of about three expansions to the temperature of saturated steam. For a small increase in the number of expansions the temperature at cut-off rapidly fell to that of saturated steam.

The author considered superheating not as a means of obtaining a thermal efficiency in any way proportional to the temperatures used, but as a device for realizing as far as possible the full thermal efficiency of saturated steam by rendering the cylinder practically non-conducting. The practical difficulties supposed to be associated with the production and use of superheated steam had been satisfactorily overcome. Experience had shown that with ordinary care as to purity of feed water, superheater tubes after long periods of severe work showed no signs of burning, scalding, or injury of any kind. With the greatly improved quality of lubricating oils no trouble need arise with the lubrication of superheated steam engines.

The best results could be obtained when the steam was supplied at about 650 degrees Fahr. at the engine. It was important to use good non-conducting material to maintain the high temperature of the steam in its passage to the engine. The best results in these trials had been obtained in association with a high range of pressure in one cylinder with a late cut-off. Any cause which tended to increase initial condensation in the cylinder with saturated steam tended also, with superheated steam, to absorb the superheat and to neutralize its useful effect in the cylinder. Superheated steam at high temperatures might be safely and advantageously used in double-acting engines. Many such engines were now at work or in course of construction.

The point requiring chief consideration in the design of engines to work with superheated steam was the steam-admission arrangements. The steam-admission valve, being subjected to the maximum temperature, should be practically frictionless, so as to remove the necessity for its lubrication.

Richmond Notes.

THE RICHMOND LOCOMOTIVE WORKS.

A visit to Richmond last month and a call at the Richmond Locomotive Works found this firm in that condition of almost complete idleness which is at present common to all of the locomotive builders of this country who have no foreign orders on their books. At the Richmond works, however, there was the promise of renewed activity; for a few days before the writer called they received one order for 10 locomotives, and another for six boilers, and these, with still another order taken some time ago for summer delivery and some miscellaneous work, while not making a rushing business, gives an improved prospect for the immediate future.

A season of idleness is not the best time to visit a shop, but a short walk through this one impresses the visitor with the fact that for years past the policy of the management has been to purchase the best of machine tools, and to buy a good many of them. The machine shop contains many fine modern tools from the best-known and most reliable builders. Milling machines are extensively used, and without exception they are heavy and substantial tools. It is found that milling is, generally speaking, much cheaper and better than planing. The saving comes from two sources—the smaller number of hours required for a given piece of work, and the fact that lower-priced men can be employed on milling machines. Other modern tools installed in these shops might be mentioned, but there is not much to be said about them individually, except that they are right up to date.

All the work in the machine shop is conducted on the piece-work plan, and with satisfaction to all concerned.

The buildings were not originally built for locomotive work and their low roofs make it impossible to use traveling cranes, except over the erecting floor, where a 15-ton rope-driven crane has been in use for years. The engines of to-day are so heavy that the need of a heavier crane is felt. The conditions which make it impossible to use traveling cranes serving the entire floor of the machine shops have been met by air hoists, many of which travel on trolleys and serve several machines each. As in other shops the advantages of compressed air are fully realized.

In the past year a 350-horse power Greene engine has been installed to furnish power for most of the plant. The engine is a fine one, and has been so placed in the engine-room as to permit of being made into a tandem compound at a later date if desired. The machine and boiler shops are so located as to make it comparatively easy to drive the machinery in them both from one engine, and when certain changes and enlargements now in progress are completed, the carpenter and pattern shops will also be supplied with power from this same engine. The machine shop has two parallel lines of shafting, and clutches near the driving pulleys make it possible to cut out either shaft and run the other alone—as in the case of a breakdown or the running of one o two large tools at night. The shafting in the boiler shop is operated by a rope drive, and a similar clutch makes it possible to run or shut down this department independently of the others.

In the boiler shop hydraulic riveters are used on the boiler work and pneumatic riveters are confined to tank work. A fine set of bending rolls driven by a small double steam engine is noticeable in the equipment of this department.

The blacksmith shop and the foundry are at present in opposite ends of the same building, but a new smith shop, 100 feet by 260 feet, has been built and is ready to be occupied. It is a frame structure, is high and well lighted. The boilers and heating furnaces are to be placed along one side of the shop, entirely outside of the building proper, but right up to the building line of that side. The roof has an overhang on that side to give shelter to them. A track on a trestle just outside of the building permits coal to be delivered by hopper cars directly to the boiler and furnace-room floors without any manual labor. When the smith shop is moved into this building the area of the foundry floor will be extended and the remainder of the present smith shop devoted to carpenter and pattern work.

These notes would not be complete without acknowledging the courteous reception given to us by Mr. Jones, Secretary of the Company; Mr. Delaney, General Superintendent, and Mr. Speirs, in charge of the boiler shop.

THE CHESAPEAKE & OHIO SHOPS.

The shops of the Chesapeake & Ohio Railroad, at Richmond, have received a recent addition in the shape of an excellent paint shop. The building is 165 feet long inside, and about 66 feet wide, the three tracks holding two cars each, or six cars altogether. The length of the tracks is sufficient for two of the longest of Pullmans. The building is excellently lighted from large windows in the walls, from the monitor in the roof and from large lights in the slope of the roof.

The roof is carried on iron trusses. The floor is concrete, perfectly drained, and altogether the building is admirably adapted to its purpose. An annex along one side of it provides storage for the paints, oils and other supplies. The only criticism that might be made is the apparent lack of adequate room for the varnishing of blinds, sashes and interior fittings.

This road lights its through passenger trains by electricity, the current being supplied entirely by Silvey storage batteries. Two plants for charging the batteries are maintained, one at Covington, Ky., and the other at Richmond. The Covington plant takes care of the cars on the Western end of the line and the trains in the Cincinnati-New York service, while at Richmond, the batteries on the cars on the Eastern end of the line are kept up. The batteries are arranged in groups of six cells, there being a total of 12 cells per coach. These 12 weigh about 1,400 pounds and will supply current for a round trip from Cincinnati to Jersey City and return, and then have a reserve of 22 hours' lighting. The batteries have a life of 17 to 18 months and cost $16 per cell complete. At the end of the 18 months the entire battery does not

need replacement, for the jar at least can be used again and the negative plates have a much greater life than the positive plates, sometimes outlasting three sets of the latter. The arrangements for handling the batteries are very complete, but they have been described several times in various journals and are doubtless familiar to our readers.

We were fortunate enough when visiting the shops recently to see a new air-brake instruction car just before it started out on its initial trip. It is about the size of a passenger coach and resembles one in outside appearance. At one end is an upright boiler with a coal bunker and water tank adjacent to it. On each side of the middle portion of the car the air brake apparatus is arranged. This consists of an engine equipment, one tender brake, one passenger equipment and 16 freight brakes. There are the usual valves in sections to illustrate their construction and operation, and a complete outfit of signal apparatus. At the other end of the car is a neat office, with a desk on it and on one side a long seat that can be made up into two berths. The toilet arrangements are complete and in all respects the car is a model one.

Several cars in local service were being equipped with a device for preventing the tipping of truck frames with the application of the brakes. The device consists of spring roller bearings secured to the floor framing with the rolls bearing on a plate or shelf secured to the end pieces of the truck frames. When the brakes are in the released position the springs in the bearings force the rolls down on to the truck end frames and the bearings are free to yield to the motion of the truck, but when the brakes are applied, connections from the brake levers key the bearings solid, so that the springs in them are inoperative. Then the truck frames cannot tip, but must remain level. The device has not yet been put into service, but it would appear to be open to the objection of transmitting unpleasant shocks and vibrations from the trucks to the car body and thus to the passengers.

We noticed in the boiler-room a hydraulic pump that is a great labor-saving arrangement for testing boilers. It consists of the steam cylinder of a 6-inch air-brake pump with a 1¾-inch hydraulic cylinder in place of the air cylinder. The pump is bolted to the wall and a pressure gage near by records the water pressure obtained. From the pump water pipes are run into that part of the shop where boilers are tested, and when a boiler is filled with water, connections are made and the engineer notified to start up the pump and maintain a certain desired pressure. Thus the old portable hand pump is dispensed with and the labor of pumping by hand avoided.

Compressed air is used in the shops to a considerable extent, and will be used more when funds are available for the purchase of air compressors. At present the air is compressed by one Pedrick & Ayer belted compressor, and the limit of its capacity has been reached. Among other uses the air is employed to press in rod bushings, and driving-box brasses. A press with a 20-inch cylinder is used. The press is also employed to force out old rod bushings, and in doing this work it was found that after the bushing once started it left the rod with a rapidity and force that was startling if not dangerous. To correct this, the foreman, Mr. Gould, put an oil cylinder on top of the air cylinder and attached the piston in the upper cylinder to that of the lower one. A port in the upper piston permits the oil to slowly pass from one end of the cylinder to the other, thus acting as a dash pot and regulating the speed of the air piston.

Mr. Sanford Keeler has been appointed to represent the Nathan Manufacturing Company in Chicago. He is a well-known railway man, having filled several important positions in the Northwest, and takes charge March 1.

The Baltimore & Ohio and B. & O. Southwestern railways are running fast freight trains between New York and St. Louis, the eastbound train being scheduled at 80 hours from St. Louis to New York, 75 hours to Philadelphia and 70 hours to Baltimore. The westbound time is even faster, being 60 hours from New York, 55 from Philadelphia and 50 from Baltimore. Arrangements have been made by the B. & O. S. W. to load cars at St. Louis direct for the Eastern cities.

The Etrusion Process for Forming Metals.

In an article on the manufacture of metallic alloys, Industries and Iron describes the process employed at the works of the Delta Metal Company in England. The Delta alloys are of various compositions, some of them being improved bronzes, while others are based upon the introduction and chemical combination of definite quantities of iron to which they owe their great strength and toughness. Some idea of the extent to which this metal is worked after casting may be gained from the equipment of the smithshop which contains two large steam hammers, a gas hammer, several olivers, a hydraulic press, a large bolt machine, two drop stamps, etc. Delta metal forges at a lower temperature and more readily than wrought iron. But what we intended to quote from the article was the reference to the etrusion machine in use at these works.

"An account of the machine was recently given in a paper before the Iron and Steel Institute. Its principle consists in forcing the metal, heated to a plastic condition, through a die, by means of a hydraulic ram. The machine is admirably adapted not only for round, square and hexagon bars, wire, angles, etc., but also for all descriptions of sections of complex design, even those which it would be impossible to roll. The molten metal is either poured into the container and allowed to cool, or it is introduced in the shape of a cast billet, which is previously heated in a furnace. The container is then turned into into a horizontal position, and the metal forced through a die held by powerful hydraulic clips in the crosshead. Numerous difficulties were naturally experienced in perfecting the process, one of the chief being the construction of the container, which has not only to withstand the high temperature of the contained metal, but likewise while under the influence of that temperature has to meet the severe strain brought upon the interior. The difficulty was overcome by constructing the container of a series of concentric steel tubes alternating with annular spaces packed with a dense non-conducting material whereby the inner liner exposed to the high temperature is reinforced by the surrounding cold steel tubes.

"The machine produces about 40 charges from one to two hundred weight each per day, and is served by two men and a lad; consequently a great saving in labor is effected, compared with rolling mills, while the hydraulic press is actuated by pumps requiring only about 15 horse-power, which is another great advantage over rolling mills. The orders for bars of all kinds of sections having increased very much, a new and more powerful machine is now being erected in spacious premises adjoining those already described. Not only bars, etc., of Delta metal are produced by this patent extrusion machine, but also of common brass, naval brass, manganese and aluminum bronze, etc.

"The diversity of objects for which it can be utilized is accentuated when the fact is mentioned that nearly 300 separate dies have already been manufactured for the machine now in use. Rods and flats varing from inch up to 3¾ inches are produced with the greatest of ease and rapidity, and are of a quality much superior to those produced in the regular way, while the machine effects a saving of somewhere about 75 per cent. in cost of production.

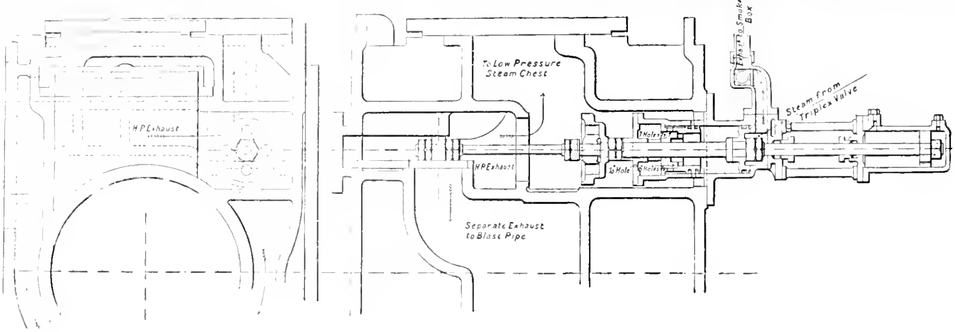
"On account of the high pressure employed in their production, extruded or pressed bars possess increased tensile strength and greater toughness. For bars of Delta No. 1 alloy, for instance, tested at the Royal Arsenal, 48 tons per square inch with 32 per cent. elongation against 38 tons per square inch and 20 per cent. elongation of rolled bars and yellow metal bars, showed an increase in tensile strength of 24 per cent., with a proportionate increase in elongation over rolled bars.

"Aluminium is treated most successfully by this process."

Intercepting Valve for Compound Locomotives on the Great Southern and Western Railway, Ireland.

We reproduce herewith from the Engineer an intercepting valve used on compound locomotives on the Great Southern and Western Railway in Ireland. It was designed by Mr. Ivatt, then Locomotive Superintendent of the road, and now with the Great Northern Railway.

"The engine is built under the Wordsdell von Borries and Lapage's patents. This valve allows the engine to be worked 'simple' or 'compound' at will. It is actuated by a small lever and rod from the footplate, which, by suitable valves, admits steam to a cylinder on the spindle of the change valve, and so moves it to either position, the movement being controlled by a dashpot. When in the 'simple' position the valve opens a communication from the high-pressure exhaust to the blast pipe, round the underside



Intercepting Valve for Compound Locomotives.—Great Southern & Western Railway, Ireland.

of the high-pressure cylinder; at the same time it closes the communication from the high-pressure exhaust to the low-pressure steam chest, and opens a connection for live steam from the steam pipe to the low-pressure steam chest. This supply of live steam is wiredrawn so as not to exceed about 75 pounds pressure on the low-pressure side, and low-pressure cylinder and steam chest are, as usual, provided with relief valves, set to blow at 75 pounds in case the pressure should exceed that amount.

"In ordinary working the engine is always run compound, and starts without any trouble, but for starting on an incline, or for getting away quickly with a heavy train, the arrangement for working simple is of great advantage, and enables the engine to exert as much power as a simple engine with two 18 inch cylinders and the same steam pressure. The arrangement is also exceedingly handy for shunting; there is no steam locked up in the receiver, and the engine does not, in steam-shed phraseology, 'beat two or three times after steam is shut off.'

"The working of the change valve is entirely in the hands of the driver. Mr. Ivatt does not believe in the theory that it is not advisable to give the driver the power of working simple if required. To argue that the driver of a compound engine so fitted is likely to work the engine simple any longer than is absolutely necessary, is about the same as saying that the driver of an ordinary engine cannot be trusted to pull the reversing gear up as soon as possible."

Steam and Electric Railway Grade Crossings.

The twenty-eighth annual report of the Massachusetts Railway Commission, relating to street railways, has an interesting chapter on grade crossings between steam roads and street railways. It begins by stating that "Since the electric car began to take the place of the horse car, attention has been called from time to time to the greater risk of casualty at grade crossings of street railways with railroads. We have felt more strongly the difficulties as well as the responsibilities of dealing with this matter since the passage of the Act of 1895, Chapter 426, which requires the consent either of this board or of a special commission to the creation of new crossings of this kind. So far, all of the applications for such consent have been made to this board. We regard it as our duty to carry out the policy intended by the legislature, and it is largely in this view that we again call attention to the subject."

The report then takes up the "Broad Cove collision" in the town of Somerset, where a New York, New Haven & Hartford passenger train collided with an electric car, smashing the latter to splinters, and derailing and overturning the locomotive and tender, and derailing the combination car. Nobody was killed and the board feels that because of that fortunate circumstance the people of the State have not drawn from the accident the lesson they should. The accident occurred in a blinding snowstorm and the electric car had not started to cross the tracks until the conductor had gone ahead and signaled that all was clear. The board thinks the collision justifies two inferences as follows:

First. The dangers at the grade crossings of electric railways with railroads are in reality more than have been taken into account. It has been commonly assumed that the railroad train, with its ponderous locomotive, would brush aside the electric car without seriously endangering its own passengers, as it usually does other highway vehicles; and it has sometimes been intimated that if the electric railway was willing to take the risk, the railroad had little occasion to concern itself. The life of the railroad passenger is of no more value than that of the electric railway passenger; but it is clearly shown by the recent case that both are likely to be involved in the same catastrophe.

Second. It is apparent that the risks at such crossings are too great, and the present provision for the security of life too small, as regards both the railway and the railroad.

"Several remedies may be suggested. (1.) The plainest remedy is the separation of the grades of the railroad and highway. There is now sufficient provision of law for doing this, except that the railway company has no power to initiate proceedings. Such power may properly be given, the railway company bearing a fair proportion of the cost.

"(2.) Where the abolition of the highway grade crossing is for any reason impracticable, the route of the electric railway may often be deflected so as to pass over or under the railroad, outside the limits of the highway. The objection is frequently encountered that the railway company can acquire land for this purpose only by purchase, and if at all, only at the owner's price. The right to take land in such case, under regulations and limitations similar, perhaps, to those which now apply in case of land required for improving the alignment of a railroad, might well be given to the railway company. Such legislation seems to us highly desirable. This remedy would not infrequently remove the prime necessity for abolishing the highway grade crossing.

"(3.) Some audible signal operated by the railroad train, such that it begins to ring when the train is 1,500 or 2,000 feet away, and continues to ring until the train has passed the crossing, might in many cases afford protection to the crossing. It is assumed that in the present stage of electrical development some automatic signal of this kind may be found which can be depended on to work reliably.

"(4.) The more effectual and sure method of protecting the crossing would be by an interlocking apparatus, similar in principle to that in use at grade crossings of railroads with each other. As applied to the crossing of a railroad with an electric railway, the former should doubtless have as a rule the right of way, with derails, if any, only on the latter. This system of protection is required in the State of Ohio as regards all new crossings, and may be prescribed as regards all crossings; and we are informed that the law of Illinois is similar."

The Hardie Compressed Air Locomotive for the Manhattan Elevated Railway.

In about a month one of the most important trials of compressed air ever made for traction purposes will begin on the Sixth Avenue line of the Manhattan Elevated Railway in this city. All the machinery for these trials has been built, and the work of installation is proceeding rapidly. The Hardie compressed air motor which is to haul the trains has been completed at Rome, N. Y., and will be sent to this city as soon as the air compressing plant is complete. Through the courtesy of the American Air Power Company, 160 Broadway, New York, who are supplying this motor for trial, we reproduce herewith two photographs of it taken at different stages of its construction. As shown in its more complete state it still lacks headlights, handrails and other small fittings that will add to its general appearance.

This motor carries within the cylindrical shell that takes the place of the boiler of a steam locomotive 36 Mannesman rolled steel tubes 9 inches in diameter. Thirty of these are 15 feet 6 inches long, while the lower six of the group are 21 feet 3 inches long and extend under the floor of the cab, almost to the buffer plate. The total capacity of these flasks is about 200 cubic feet.

The Hardie Compressed Air Locomotive.

Air will be stored in them at 2,000 pounds pressure per square inch. From these reservoirs the air goes at a reduced pressure of 150 pounds to a vertical re-heater placed in the cab. This re-heater resembles a vertical boiler in appearance and is about 30 inches in diameter. It will be charged with water at a temperature of about 350 degrees Fahr. and can be maintained at that temperature by a small fire under it. The air as it comes from the reservoirs is very dry and of normal temperature. As it passes through the water it not only receives heat but also takes up moisture until the dew point is reached. Experiments with a similar motor, which has operated very successfully for nearly eight months on the street railways in New York City, shows that on the average the amount of moisture taken up is .0188 pounds of water per cubic foot of free air. From the re-heater the air goes directly to the working cylinders. These are 13 inches in diameter by 20 inches stroke.

In designing this locomotive the American Air Power Company were compelled by circumstances to follow quite closely the proportions of the steam locomotives on the road. The total length of the engine from bumper to bumper had to be the same as the present engines, viz., 23 feet 9¾ inches, so that all stop signals at the stations would be right for this motor. The limit of weight of the present steam locomotives is 47,000 pounds, and this figure had to be met in the new motor, and furthermore that weight had to be carried on the same total wheel base, so as not to overtax the elevated structure. The driving wheel base is 6 feet, and the total wheel base is 16 feet 1 inch. The drivers are 42 inches in diameter. With the exception that the cylinders are placed under the cab, the details of the running gear are somewhat similar to those of the steam locomotives on the road, but they have been designed throughout for a pressure of 200 pounds per inch, and a speed of 50 miles per hour. To accomplish this and come within the specified weight very careful designing was necessary. It will be noticed in one of the views given herewith that the driving axles and crank pins are hollow.

It is our purpose to illustrate this engine in detail later on, and we will therefore reserve further description until that time. The power station to supply the compressed air is as interesting as the locomotive itself.

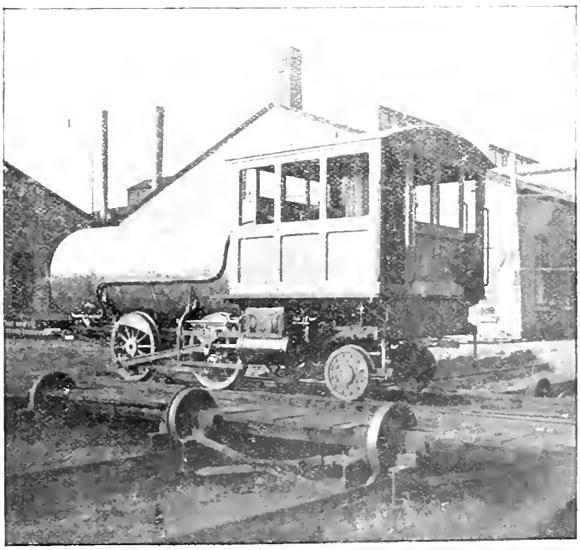
It is located at 98 and 100 Greenwich street, and a four-stage compressor built by the Ingersoll-Sergeant Drill Company is already in position.

This compressor has two 18-inch by 36 inch Corliss steam cylinders and placed tandem with them are four single-acting air cylinders, two to each steam cylinder.

These air cylinders are 21¼, 9, 7 and 3 inches in diameter, by 36 inches stroke.

One begins to realize what compression to 2,500 pounds means when he looks into a 21¼ by 36-inch cylinder and realizes that its volume of air is packed into one end of a 3-inch cylinder before the desired pressure is attained. Of course, the air passes through inter-coolers between each two stages of compression, and it is also cooled immediately after leaving the last cylinder. This compressor will deliver the air at a pressure of 2,500 pounds per square inch into a large nest of Mannesman tubes, similar to those on the locomotive. There are to be 144 tubes all nine inches in diameter, most of them 15 feet 6 inches long, and a few of them 21 feet 3 inches long. The air is thus stored at a pressure 500 pounds in excess of the storage pressure on the locomotive, so that when the latter is charged the storage volume and pressure are sufficient without drawing directly upon the compressor.

One cannot but be impressed with the thoroughness with which the plans have been worked out and the preparations made for an extensive trial of this system of traction, and the performance of the plant will be awaited with interest.



The Hardie Compressed Air Locomotive.

(Established 1832.)

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

25TH YEAR. 66TH YEAR.

PUBLISHED MONTHLY

BY

R. M. VAN ARSDALE,

MORSE BUILDING.......................NEW YORK

M. N. FORNEY, W. H. MARSHALL, } Editors.

MARCH, 1897.

Subscription.—*$2.00 a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union.*

EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay*, EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Special Notice.—*As the* AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL *is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 25th day of each month.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* **When a subscriber changes his address** *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

The paper may be obtained and subscriptions for it sent to the following agencies: **Chicago.** *Post Office News Co., 217 Dearborn Street.* **London, Eng.,** *Sampson Low, Marston & Co., Limited St. Dunstan's House, Fetter Lane, E. C.*

Secretary Herbert, on Feb. 17, signed an order abolishing the Naval Steel Board, and transferring its work to the bureaus of steam engineering and construction. In so doing, he has rid the navy of a board that for 12 years has been a source of constant trouble, and has assigned the work performed by the board to parties more capable of giving it intelligent supervision.

The attempt to form an association of round-house and railway machine shop foremen, which we understand is being made, is worthy of encouragement from the superior officers of these men. It is natural to conclude somewhat hastily that we already have too many railway associations, but while there is something to be said on this point there is also much to be said in favor of this particular movement. Nothing so stimulates the mental activities as to get away from the details of one's business for a few days and see and hear what others in the same line of work are doing. This being true, the fewer opportunities a certain class of men have to get away from their work, the greater we would expect the benefits to be of association and organization among them. This seems to be the situation among the foremen, and it appears to us that the proposed association would prove beneficial to the men themselves, and through them to the companies they serve.

It is stated that the flattering results of tests of a Parsons steam turbine for marine propulsion, recorded in these pages last month, has led the British Admiralty to seriously consider giving it a trial in a number of launches and torpedo-boats in the British Navy. The turbine would appear to be well adapted for such work, for with its high speed, it gives large power without involving great weights, and, as we know, this desirable feature is obtained without a sacrifice of economy. The propelling machinery of the boat, whose preliminary trials we mentioned last month, consists of three shafts, each driven by a steam turbine, and each having three propellers, the second being of coarser pitch than the first, and the third being coarser still. Thus there are nine propellers in all, and they run at the high rate of 2,400 revolutions per minute. In the preliminary trials a speed of 29.6 knots was obtained, the boat being only 100 feet long and 42 tons' measurement. By a change in the pitch of the propellers it is expected that over 30 knots will be obtained. Steam is supplied by one water-tube boiler.

It is somewhat singular that with the intense interest manifested in compound locomotives for some years past in this country—an interest that seemingly allowed few details to escape study—the question of the ratio between the cylinder volumes, should not have been the subject of experimental work. The proper ratio for locomotive work cannot be derived from experience in stationary or marine work, for the reason that the working conditions are so different, particularly the wide range of cut-off employed on the locomotive. The practices of railroad companies and builders have varied greatly, the ratios at present ranging from three to one to a little more than two to one. The testing plant of the Chicago & Northwestern Railway is expected to soon furnish data on this important subject. In making certain alterations on a two-cylinder locomotive the question of cylinder ratios came up, and, in view of the lack of definite information on the subject, it was decided to make some experiments, particularly as various ratios between two and three to one could easily be obtained by bushing the high-pressure cylinder of the locomotive in question. The result should afford a valuable contribution to available knowledge on the proportions of compound locomotives.

Perhaps no better example can be found of the manner in which poor inventors are deluded into entertaining extravagant hopes of rewards for inventions than is given by the stories circulated about the "Sleepy Eye" rotary engine. The engine as illustrated in the patent papers has two characteristics, the first of which is that it will not run at all, except it be from the impact of inflowing steam, rather than by its direct pressure, in which case the power produced would be infinitesimal compared with the steam used; the second characteristic is that the engine is reversible. The patent shows a construction that must be classed with the worst rather than with the best of rotary engine designs. There is nothing new about it, and several years ago we saw in Chicago a rotary with the same reversing valve, also arranged with considerable ingenuity to provide for using the steam expansively. How the "Sleepy Eye" engine patent papers could go through the hands of an honest and capable attorney and a conscientious patent examiner without being criticised for being without novelty we leave our readers to explain to their own satisfaction. And yet the story of how this patent has been sold to an English syndicate for from $1,000,000 to $7,100,000 spot cash has been circulated around the entire globe. One of the greatest sinners concerned in circulating this story is a contemporary interested in patents and patent soliciting, who prints the story of the sale and gives without comment of its own the informattion that the inventor has already received a check for an enormous sum. The patent is a poor protection to a poorer design and reliable journals would be better employed in exposing the worthlessness of such so-called inventions than in circulating doubtful stories of fabulous profits reaped by incapable inventors.

COMPRESSED AIR AND ELECTRIC TRACTION IN NEW YORK.

Recent developments would seem to indicate that in New York City electric traction will soon have an opportunity to achieve wonderful successes, while in the same city it must also meet and vanquish, if it can, its at present vigorous competitor, compressed air traction. Just as we go to press officials of the Manhattan Elevated Railway announce that General Manager Fransioli, after personally investigating the operation of the electrically equipped elevated roads in Chicago, has so strongly endorsed electric traction in a report to the Executive Committee of the Board of Directors that it has been decided to give the same system a trial on the Manhattan lines, and that a beginning will be made on the Second avenue line. At the same time the Metropolitan Company is preparing to equip its Sixth and Eighth avenue surface lines with an electric conduit system similar to that used for some time on the Lenox avenue line. Thus electricity has evidently the opportunity to add two more triumphs to its long list of successful applications to heavy city traffic.

But compressed air is going to have its day too. The Hardie air locomotive will in about a month be in operation on the Sixth avenue line of the Manhattan Elevated Railway, and the same type of motor has for months been in service on the 125th street service line. The Metropolitan is also to give a different form of compressed air motor a trial on its lines, so that in both surface and elevated traffic compressed air will have a chance to show what it can do. It is not exaggeration to say that these compressed air trials will be watched with great interest by those concerned in urban and interurban traffic. We are informed that there is a constant stream of visitors from all parts of the country to see the air motor on the 125th street line and that the interest taken in it is phenomenal. Notwithstanding all that is said to the contrary, the desire is general for a motor that is not at all times dependent upon the power-house, and if compressed air and the brains and capital enlisted in its development can furnish such a motor, one that is commercial and financially a success, a hearty welcome will be accorded it.

BALANCED SLIDE VALVES.

An English contemporary, noted for its chronic distrust of all things American, recently undertakes to discuss balanced slide valves, and the need of them on English engines. It begins with a disclaimer of all intention of vouching for the truth of the statement—contained in a report to the Master Mechanics' Association last year—that 15,000 locomotives in this country are fitted with Richardson balanced valves. Probably it has not occurred to our contemporary that its voucher is not needed and that the report alluded to will be credited as truth everywhere except in its own editorial sanctum. However, having relieved itself of all responsibility in connection with this statement, it enters into the subject from an English standpoint, and comes to the very sensible conclusion that with the larger valves now common there it becomes desirable to take up anew the question of balancing.

In English practice it has been uncommon to use balanced valves because they have not been a success. One reason for this appears to be the use of cylindrical rings, which have almost invariably proved a failure, though there is an improved form of this type of balance now in use in this country for which good results are claimed. The four straight strips forming a rectangular enclosure on top of the valve hold the record for reliability in this country. The early forms of cylindrical rings used in England appear to have given so much trouble from sticking that the balance plate under the steam-chest cover has been placed at a slight angle to the valve seat instead of parallel to it, so as to give the rings some motion and prevent sticking. One surprising objection urged against the balanced valves is that "unless some form of relief-valve is fitted to the cylinders, a locomotive with a balanced valve will, when running down an incline, draw in cinders from the smokebox through the exhaust." A little reflection ought to show any one that a balanced valve has no monopoly on the cinder-drawing business, and that air valves—which are held to be a complication—are good things to have on any engine that must occasionally run with steam shut off. Our contemporary suggests such a simple (?) way of getting rid of those complicated relief valves: It would so connect the cylinder cocks with the throttle that the closing of the latter would open the cocks, but while steam was on the cocks could be opened by the engineer. We would estimate the probable diameter of cylinder cocks doing duty as air valves at not less than 2 inches on a passenger engine, and have a vision of a cylinder cock rigging extended up to the throttle, and made about 10 times as strong as the present construction in order to open the large valves under pressure, and can imagine the exasperating experiences of the engineer who tries to get water out of the cylinders, and finds that all the steam goes too. Delightful is it not? Why should not our English contemporary own up that the present American practice in balanced slide valves and relief valves is all right? It is not an acknowledgment of greater ability on the part of Americans; conditions here simply compelled to solve the problem before the need of a solution was felt in England.

THE RAILWAY PROFESSION AND A TRAINING THEREFOR.

At the January meeting of the New York Railroad an interesting topic was brought up for discussion by a paper on "The Profession of the Railway, and a Suggested Course of Training Therefor." It is a subject that many railroad men are thinking about, if we can judge by the readiness with which they entered into the discussion. We would hardly expect to hear a dissenting voice in a discussion on the need of special training or the advantage of special education for those who are to be entrusted by railroad companies with great responsibilities. But when we come to consider how that education shall be obtained and of what it shall consist there is every opportunity for a divergence of opinion.

After listening to the discussion at the meeting referred to, we felt that at the outset the term railway profession needed a definition as different speakers seemed to have different ideas in mind when using the term. Possibly it would be best for us to leave the definition to those who originated the term, but if we consider for the moment that proficiency in the railway profession embraces all those qualities which are needful to the intelligent and successful management of railway properties, it is evident at once that the field covered by the railway profession is a large one. Furthermore, a study of the lives of those who have been most successful in this field seems to teach us that the groundwork for that profession is not confined to any one course of business or technical education. Some of the most capable men at or near the heads of our great corporations have started as civil engineers; others have made their beginning in the traffic or operating departments, while a few have made their first great successes in the mechanical department. Few of these men are well grounded in *all* these branches of railroad operation and management, and yet they are successful in the higher positions to which they have been called. In the special education for the railway profession, what shall be emphasized—engineering, operation, finance or law?

Without necessarily differing from those who are pleading for the special education, we would like to make a suggestion. If the great business of transportation is such a factor in the engineering, business, commercial, financial and social worlds, why should it not receive its proper share of attention in the regular courses of studies in our colleges and technical schools? That it has not been so recognized is evident upon reflection. We have our engineering schools and colleges, for instance, and in them a student can study and test stationary engines, steam turbines, gas engines, electric motors, etc., but there is only one University in the whole world (Purdue) that has considered steam engineering as applied to locomotive practice to be of sufficient importance to warrant it in spending money for a locomotive testing plant as a part of its laboratory. And so we might go through all the other professions or sciences that touch the great business of railroading or transportation in general, and we will find that in them also railroading has been pushed aside or lightly touched upon in our

colleges and universities. Those responsible for this condition of affairs owe the railroad fraternity an apology for their neglect.

If the railway profession is accorded its proper place in the curriculum of our universities, several advantages will accrue; first, the public will be gradually educated on a subject that is of importance to it, even if every student does not engage in the business actively, and ultimately this public will be more just to the railroads; second, the young men destined to engage in railroad work, but who would not be likely to take up the special course can in a measure be fitted for their future duties; and, third, such a course would not in the least interfere with a special training, such as has been suggested.

STEEL CAR FRAMES.

We would call attention to an article on the repairs of French cars which appears elsewhere in this issue. The interest at present taken in steel cars in this country warrants us in giving considerable space to this subject. While it is true that French construction and French practice in general will not strictly apply to the conditions in this country, there is much to be learned from their experience. The method of conducting repairs and their expense, the results of collisions in distorting steel frames, and many other similar matters are subjects on which railroad men feel the need of enlightenment before they do much with steel cars. This knowledge cannot be obtained to any great extent from experience in this country and must be sought for abroad.

The article alluded to is so complete that we would only take the space to emphasize a few points. It will be noticed that the most satisfactory car is one in which the sections composing the frame are made heavy. We know it is possible to get a strong steel frame that is lighter than a wooden one, but care should be exercised to have no very light sections used in its construction or corrosion and deterioration will weaken it rapidly. The aim should be to have heavy sections, even if they are made fewer in number.

Then in the matter of repairs it is found that it pays to keep steel parts in stock to replace damaged parts, thus keeping the car out of service the minimum of time, and straightening or otherwise repairing the damaged parts at leisure (if they can be repaired) and putting them in stock for use on other cars. The cost of repairs is by this method found to be lessened. This immediately suggests that if steel underframes are to come into general use in this country it is of great importance that we get down to standard dimensions. And there is no reason why we should not. The task will not be easy, but the results will pay for all the labor expended in this direction.

The heavy repairs will, in all probability, have to be done at a few leading points, but it is not be anticipated that the inconvenience of so doing will be great. The more the repairs to steel cars can be concentrated the less they will cost.

One of the most striking facts brought out in the article mentioned is the ultimate saving from the longer life of the steel frames. Though their first cost is greater, their lesser repairs make their total cost at the end of a few years no greater than wooden frames and after that time the showing in favor of the steel cars increases rapidly, as will be shown on a full page diagram next month. We believe that notwithstanding it deals with French cars the article will be of value to those interested in steel cars in America.

NOTES.

Our esteemed contemporary The Railroad Car Journal contemplates building—with the aid of various railway supply houses—a private car for the President of these United States. We know the government is poor and that it has to issue bonds to pay expenses, but we did not dream it was reduced to such straits as this.

Last month a special train on the C., B. & Q. R.R., consisting of an engine and one car, made a run from Chicago to Denver, 1,026 miles, in 18 hours and 52 minutes. It is probably the best long-distance run on record when we consider the mountainous country through which the train passed in the latter half of its journey. The average speed, including stops, was 54 miles per hour.

On some of the new freight engines built for the Baltimore & Ohio by the Pittsburg Locomotive Works the new Bell Spark Arrester, invented by Mr. J. Snowden Bell, has been applied. The new arrangement consists of a double perforated deflecting plate, and the disposition of the netting in a series of inclines, with no horizontal surface except a very narrow one on each side of the exhaust pipe. It is said that this arrangement not only prevents the escape of so many live sparks, but it preserves the life of the netting, and is, therefore, more economical and effective than any spark arrestor now in use on any other road.

An ingenious reflector for a water gage glass is illustrated by the *Engineer*. It is perforated just behind the glass with three vertical rows of holes about $\frac{3}{16}$ of an inch in diameter. These holes are seen without distortion through the part of the glass that is without water, but viewed through the water the three holes in each horizontal row appear elongated into one narrow slit. The distinction between the two parts of the tube is said to be very sharp. The reflector is coated with plain enamel or luminous paint as preferred. This same gage is enclosed in a tube of tough wired glass to prevent injury from the flying pieces of a broken water glass.

Torpedo boat, No. 6, built by the Herreshoffs at Bristol, R. I., made her official trial trip last month. The contract speed was 27½ knots, but in five runs over a course of 12 nautical miles the average speed was 28.73 knots, notwithstanding that one of the blowers became deranged during the last 12 miles-spin, making that particular run much below the average. The highest speed for 12 miles was almost exactly 29 knots. These figures are, however, subject to small corrections when all the calculations of the Board are completed. In its preliminary report, the Board says: "At her great speed the vibration was very slight, even over the screws, and there was no evidence of that effort and strain ordinarily noticeable on full power trials. Only a very slight wave was produced."

The floor of the new electric light station in Paterson, N. J., is a novel one. According to Power, it consists in effect of a huge casting of concrete, forming an undivided floor for the whole station. It is 4 inches thick, but at intervals of 15 feet there are cast on the under side beams 18 inches deep and 9 inches wide, running crosswise of the station and resting upon supporting piers of brick. The floor is further stiffened by longitudinal ribs 14 inches deep and tapering from 6 to 4 inches in thickness, spaced about 4 feet centers and bridging the spaces between the heavier crosswise ribs. These ribs are a unit with the floor. The floor is said to have cost one-third less than a floor involving the use of iron beams. It presents a surface that is never slippery and that is easily kept clean.

The new twin-screw freight and passenger steamer *Pennsylvania*, of the Hamburg-American Line, was placed in commission Feb. 18 on the regular service between New York and Hamburg. She left New York on that date with a full cargo, carrying a total of over 18,500 tons measurement. This is the largest cargo that was ever taken out of New York on one ship, or for that matter the greatest that any ship in any part of the world carried. To form an idea of the enormous quantity which this amount of freight represents, it is interesting to note that it would take 616 ordinary freight cars, or about eighteen freight trains, to transport it. Among its miscellaneous cargo the Pennsylvania carries 294,069 bushels of grain, equaling 6,847 tons, which is in itself more than the average freight steamer can take, if completely filled.

A press dispatch from Washington, under date of Feb. 15, states that Mr. Lorimer, of Illinois, after conference with the Secretary of the Navy, introduced a bill in the House to authorize that official to make a twenty-year contract with the Illinois Steel Company to supply armor plate for ships at $200 per ton, which is $263 per ton less than the present price. Mr. Gates, the President of the Illinois Company, was in the city some days, and says that his associates will agree to put up a plant to cost $3,500,000 if the contract asked for is awarded them.

An interes ing instance cf an hydraulic accumulator being supplanted by that alert agent compressed air comes from New England. An hydraulic system was in use in a factory where many presses were employed on work which required the full pressure to be attained regularly and promptly. It often occurred that when the water pressure was rapidly turned on and off from a press the work would be spoiled because the full pressure was not realized. This lack of pressure was found to be due to the inertia of the accumulator—it could not move fast enough to maintain the pressure on the ram of a press during its entire stroke and it required a moment of time at the completion of the stroke to give the maximum pressure. To prevent the spoiling of work from this cause the accumulator was removed and a small Norwalk compressor was installed and employed to maintain the required pressure on the hydraulic system. It does its work satisfactorily and no matter how quickly the presses are operated the compressed air follows up the flow of water and keeps up the pressure.

The New York, New Haven & Hartford Railroad turned out of its New Haven shops about a month ago a coach sheathed with No. 30 sheet copper. The outside sheathing is the narrow kind so much used and each board has been separately covered with the copper before being put into place. The copper is lapped into the groove and around the tongue. The window panels, letter boards, etc., are all covered so as to be practically water proof. The entire exterior is covered with copper except the doors, window sashes, hoods, platforms and roof. Painting and varnishing in thus avoided. The copper was oxidized after being put in place, but it can be put on as it comes from the mills and allowed to oxidize by the action of the atmosphere. The advantages of the copper sheathing are no deterioration of the finish, time saved over painting and varnishing and ease of repair. It is claimed the cost is not greater than painting and varnishing. The weight of copper used was about 1,000 pounds, but the wood sheathing underneath was thinned sufficiently to keep the weight of the car the same as before. The metal sheathing is the idea of Mr. W. P. Appleyard, Master Car Builder.

Powerful Compound Locomotives for the Northern Pacific Railway.

In our issue of December, 1896, we mentioned the fact that the Schenectady Locomotive Works were building for the Northern Pacific Railway four Mastodon or 12-wheeled compound locomotives of great power. These engines we now illustrate in the full-page engraving on the next page.

The engines are the most powerful of this type ever built. They are two-cylinder compounds with high pressure cylinders, 23 inches in diameter by 30 inches stroke and low-pressure cylinders 34 inches in diameter by 30 inches stroke. The intercepting valve is of the new design gotten out by the Schenectady Locomotive Works, which enables an engine to be operated as a simple or compound engine at will.

The boiler is 72 inches in diameter at the front end. It is of the extended wagon-top style and for much of its length is of greater diameter than this figure. It is designed for a working pressure of 200 pounds per square inch, and this pressure, combined with its large diameter, called for very heavy construction. Consequently we find sheets from $\frac{9}{16}$ to ⅞ inch thick used for the shell. The material is carbon steel, as is also that of the firebox.

The grate is 120$\frac{3}{16}$ inches by 42 inches, and has an area of 35 square feet. The heating surface is greater in area than has ever been obtained before in locomotive practice, namely 2,913.4 square feet. The weight of the engine is 186,000 pounds, of which 150,000 pounds is on the drivers. We give herewith a complete specification of the engine:

General Dimensions.

Gage	4 feet 8½ inches
Fuel	Bituminous coal
Weight in working order	185,000 pounds
" on drivers	150,000 pounds
Wheel base, driving	15 feet 6 inches
" " rigid	15 feet 6 inches
" " total	26 feet 4 inches

Cylinders.

Diameter of cylinders	High pressure, 23 inches; low pressure, 34 inches
Stroke of piston	30 inches
Horizontal thickness of piston	4¾ inches and 5¾ inches
Diameter of piston rod	3¾ inches
Kind of piston packing	Cast-iron rings, sprung in
" " rod packing	Jerome metallic
Size of steam ports, high pressure, 20 inches by 2⅛ inches;	low pressure, 23 inches by 2⅛ inches
Size of exhaust ports, high pressure, 20 inches by 3 inches;	low pressure, 23 inches by 3 inches
Size of bridges ports	1⅜ inches

Valves.

Kind of slide valves	Allen-Richardson
Greatest travel of slide valves	6½ inches
Outside lap " "	1⅛ inches
Inside clearance " "	¼ inch
Kind of valve stem packing	Jerome metallic

Wheels, etc.

Diameter of driving wheels outside of tire	55 inches
Material " " " centers	American cast steel
Tire held by	Shrinkage
Driving box material	Cast steel on main only, balance steeled cast iron
Diameter and length of driving journals, main	9 inches by 10 inches
" " " " " " all others	8½ inches by 10 inches
" " " " main crank pin journals, side rod,	7 inches diameter by 5¼ inches; main, 6½ inches diameter by 6 inches
Diameter and length of side rod crank pin journals,	intermediate 5½ inches diameter by 5 inches; F. & B., 5 inches diameter by 3¾ inches
Engine truck, kind	4-wheel, swing bolster
" " journals	6 inches diameter by 11 inches
Diameter of engine truck wheels	28 inches
Kind " " " "	Steel tired, cast-iron spoke center

Boiler.

Style	Extended wagon top
Outside diameter of first ring	72 inches
Working pressure	200 pounds
Material of barrel and outside of firebox	Carbon steel
Thickness of plates in barrel and outside of firebox	½, $\frac{11}{16}$, $\frac{13}{16}$, ⅞, ¾, ⅝ and $\frac{9}{16}$ inch
Horizontal seams,	butt joint, sextuple riveted, with welt strip inside and outside
Circumferential seams	Double riveted
Firebox, length	120$\frac{3}{16}$ inches
" width	42 inches
Firebox, depth	Front, 77 inches; back, 73½ inches
" material	Carbon steel
" plates, thickness	Sides, [illegible] inch; back, $\frac{5}{16}$ inch; crown, ⅜ inch; tube sheet, ½ inch
" water space	Front, 4½ inches; sides, 3½ inches to 4 inches; back, 3½ inches to 4½ inches
" crown staying	Radial stays, 1⅛ inches diameter
" staybolts	Sligo iron, 1 inch diameter
Tubes, material	Charcoal iron, No. 12, W. G.
" number of	332
" diameter	2¼ inches
" length over tube sheets	14 feet 0 inches
Fire brick, supported on	Water tubes
Heating surface, tubes	2,721.6 square feet
" " water tubes	15.3 square feet
" " firebox	206.51 square feet
" " total	2,943.41 square feet
Grate surface	35. square feet
" style	Rocking
Exhaust pipes	Single
" nozzles	5¼ inches, 5½ inches and 5¾ inches diameter
Smoke stack, inside diameter	18 inches at top, 16 inches near bottom
" " top above rail	14 feet 10 inches
Boiler supplied by	Two Sellers improved Class M. No. 10½ injectors

Tender.

Weight, empty	36,300 pounds
Wheels, number of	8, cast-iron plate wheels
" diameter	33 inches
Journals, " and length	4½ inches diameter by 8 inches
Wheel base	15 feet 3 inches
Tender frame	10-inch steel channels
" trucks	4 wheel channel iron frame
Water capacity	4,000 U. S. gallons
Coal "	7½ (2,000-pound) tons
Total wheel base of engine and tender	53 feet 8 inches
" length " " " "	62 feet 1 inch

The engine is provided with the American brake operated by air on all drivers, the Le Chatelier water-brake on cylinders, the Westinghouse automatic air-brake on tender and for train, the Westinghouse air signal, three 3-inch Ashton safety valves, magnesia sectional covering on boiler, dome and cylinders, Dean's sand feeding device, Kewanee reversible brakebeams, and the McIntosh blow-off cock.

POWERFUL TWELVE-WHEELED COMPOUND LOCOMOTIVE FOR THE NORTHERN PACIFIC RAILWAY

Built by the Schenectady Locomotive Works, Schenectady, N. Y.

Personals.

Mr. E. V. R. Thayer has been elected Vice-President of the Chicago & West Michigan Railway.

Mr. James E Worswick, Master Mechanic of the Georgia & Alabama at Americus, Ga., has resigned.

Mr. G. M. McIlvain has been appointed Receiver of the Sharpsville Railroad, with office at Sharpsville, Pa.

The Governor of Illinois has nominated for Railroad Commissioners Charles S. Rannells, C. J. Lindley and J. Bidwell.

Mr. H. F. Forrest has been appointed Manager of the Great Northwest Central, with headquarters at Brandon, Man.

Mr. Robert H. England has been appointed General Manager of the Oconee & Western, with headquarters at Empire, Ga.

Mr. William Aird has been appointed Acting Master Mechanic in charge of the Montreal shops of the Grand Trunk Railway.

Mr. M. G. Howe has resigned as General Manager of the Houston, East & West Texas, but will continue as Vice-President.

Mr. R. E. Smith, of the Atlantic Coast Line, has been appointed Superintendent of Motive Power, with office at Wilmington, N. C.

Mr. Dickerson MacAllister, Chief Engineer of the Metropolitan Elevated road of Chicago, was last month appointed Receiver for that road.

Mr. C. M. Ward, formerly General Manager of the South Carolina, has been appointed Receiver of the Greenwood, Anderson & Western.

Mr. H. R. Harris has been appointed General Manager of the Lake Superior & Ishpeming, with headquarters at Marquette, Mich.

Mr. John Boynes, for 31 years Superintendent of the passenger-car shops of the Pennsylvania at Altoona, died at Altoona on Tuesday last.

Mr. I. M. Schoomaker, formerly Vice-President, has been elected President of the Pittsburgh & Lake Erie, and J. P. Wilson, of Youngstown, becomes Vice-President.

Mr. J. W. Fitzgibbon has been appointed Assistant Superintendent of Motive Power and Equipment of the Chicago, Rock Island & Pacific, to succeed Mr. H. Monkhouse, resigned.

Mr. James Collinson was, on Jan. 20, appointed Superintendent of Motive Power and Machinery of the Gulf, Colorado and Santa Fe, to succeed Mr. George A. Hancock, recently resigned.

The Baldwin Locomotive Works are now represented in the West by Mr. William Rhodes, the Assistant Superintendent of the works. Mr. Rhodes' office is at 1217 Monadnock block, Chicago.

Col. George W. Dunn has been nominated by the Governor of New York as Railroad Commissioner to succeed Alfred C. Chapin, and Ashley W. Cole and Frank M. Baker have been renominated.

Mr. R. W. Moore has been appointed Division Master Mechanic of the Pittsburgh Division of the Baltimore & Ohio Railroad, with headquarters at Glenwood, Pittsburgh, vice Thomas Trezise, resigned.

Mr. J. A. Miller, Private Secretary to General Manager Ashley of the Ann Arbor Railroad, has been appointed purchasing agent of that road, to succeed Mr. Frank S. Chandler, resigned. Headquarters, Toledo, O.

Mr. N. S. Meldrum, formerly Secretary and Treasurer of the Houston, East and West Texas, has been appointed General Manager of that road, with headquarters at Houston, Tex., vice Mr. M. G. Howe, resigned.

Mr. C. F. Quincy, Treasurer of the Q & C Company, was elected Vice-President of the National Association of Manufacturers at the Philadelphia meeting. He represents the State of Illinois in the list of Vice-Presidents.

Chief Engineer William S. Smith, U. S. N., who has for three years past been stationed in Philadelphia as a member of the Naval Examining Board, engaged in the examination of engineers for promotion, died on Feb. 7 at his home in that city.

Mr. Geo. Royal, Jr., has resigned the Western agency of the Sterlingworth Railway Supply Company, and has accepted a position with the Nathan Manufacturing Company, as Assistant in the Western Department, with office at 147 E. Van Buren Street, Chicago, Ill.

The following changes are officially announced on the San Francisco & North Pacific: Mr. A. W. Foster has been elected General Manager, vice Mr. H. C. Whiting, resigned, and will continue to perform his duties as President. Mr. W. G. Corbaley having resigned, the office of Superintendent was abolished. Mr. H. C. Whiting has been appointed General Superintendent. Mr. F. K. Zook has been appointed Assistant Superintendent, in addition to his duties as Chief Engineer.

The following changes have taken place in the mechanical department of the Atchison, Topeka & Santa Fe: Mr. T. Paxton, Master Mechanic at Nickerson, Kan., is appointed Master Mechanic at Fort Madison, Ia., to succeed Mr. James Collison. Mr. J. E. Gavitt is appointed Master Mechanic at Nickerson, Kan., to succeed Mr. Paxton. Mr. G. T. Neubert, foreman at Wellington, Kan., is appointed Master Mechanic at Arkansas City, Kan., to succeed Mr. John Kirk, resigned. Mr. F. G. Tisdale, foreman at Atchison, Kan., is transferred to Newton to succeed Mr. Gavitt.

Mr. George Royal, Sr., Western Manager of the Nathan Manufacturing Company, died at his home at Oak Park, Ill., Feb. 5, at the age of 59 years. Mr. Royal was born at Manchester, England, in 1837, and came to this country in 1863, entering the Erie shops at Susquehanna as a machinist. In 1868 he was appointed Master Mechanic of the Central Pacific shops at Truckee, Cal. In 1875 he became Master Mechanic and Superintendent of the Eureka & Nevada Road which position he resigned in 1878 to take the Western management of the Nathan Manufacturing Company. Mr. Royal was well known among railroad men; he was a man of deep religious convictions and through his sympathy and work for railroad employees won their respect and confidence everywhere. Some of our readers not personally acquainted with him will remember him as a regular attendant at the June conventions, where he frequently, in the absence of a clergyman, led in the prayer with which those meetings are opened.

Mr. Frank Thomson, who was last month appointed President of the Pennsylvania Railroad Company to succeed Mr. Geo. B. Roberts, deceased, first entered the service of the company at the age of 17, when he entered the car shops at Altoona. At the age of 20 he became the valued assistant of Mr. Scott in the management of the military railroads engaged in moving the Union armies during the Civil War. He was engaged in this responsible work for three years. In 1864 he was appointed Superintendent of the Eastern Division of the Pittsburgh & Erie; in 1873 he became Superintendent of Motive Power of the road: in 1874 he was elected General Manager of the Pennsylvania lines east of Pittsburgh and Erie; in 1882 he became Second Vice-President of the company; and since 1888 he has been First Vice-President. Mr. Thomson has always followed closely the improvements in the details of railroad construction and operation, and many of the improvements of the road in track, stations, safety appliances, etc., originated and have been carried out under his direction. Commenting on his election a Philadelphia writer says: "The election of Mr. Thomson to the Presidency of the great corporation is a guarantee to the public, and to those whose financial intesests are closely associated with and dependent upon the prosperity of the road, that its multifarious activities will continue to be directed with the masterful business sagacity, farsightedness and fidelity which have so long characterized its direction."

The election of Mr. Frank Thomson to succeed the late Geo. B. Roberts as President of the Pennsylvania Railroad Company

has led to several other changes in the high offices in that company. Mr. J. P. Gillen, who has been Second Vice-President, has been elected to Mr. Thomson's former position of First Vice-President: Mr. Charles E. Pugh, formerly Third Vice-President becomes Second Vice-President; Mr. S. M. Prevost, formerly General Manager, is third Vice-President: Mr. Samuel Rea, who was Mr. Roberts' assistant, is First Assistant to the President; Messrs. Wm. A. Patton, who was General Assistant, and Mr. E. T. Postlethwaite, who was Assistant to the First Vice-President, are elected Assistants to the President; Mr. Wm. H. Joyce, formerly General Freight Agent, has been elected to be Freight Traffic Manager, and Mr. J. B. Hutchinson, formerly General Superintendent of Transportation, has been elected General Manager.

The First and Second Vice-Presidents have each advanced one grade, but they will retain in their new positions the duties of the old. Captain Green will have charge of the finances of the company, which he has managed so admirably in the past. Mr. Pugh will retain his special supervision over the affairs of the transportation department, which has been his work since he was elected Third Vice-President, and which he has managed with great success. As Third Vice-President Mr. Prevost will have charge of all the passenger and freight traffic interests. Mr. Rea will be the adviser of the President in engineering matters, a position for which he is eminently fitted. Mr. Patton has been so long connected with the office of the President that his knowledge of the affairs of the company will be invaluable to the new President. Mr. Postlethwaite has been connected with Mr. Thomson in his various positions for about twenty-five years, his responsibilities becoming greater with each advance of his chief, so that he brings to his new position a long training and a wide experience.

George B. Roberts.

Mr. Geo. B. Boberts, President of the Pennsylvania Railroad Company and of the Pennsylvania Company, died Jan. 29, at his home near Bala, Pa. In his death the great railway corporation which was so fortunate as to have his services for about 40 years of his life has lost an officer of noble character and remarkable ability. Mr. Roberts was born Jan. 15, 1833, in Lower Merion Township, Pa. He was educated as a civil engineer at Rensselaer Polytechnic Institute, and in 1851 he entered the service of the Pennsylvania Railroad as a rodman. Later he became assistant engineer of the Philadelphia & Erie road, and for some years after was employed on the construction work of various roads. In 1862 he returned to the Pennsylvania Railroad, and in 1869 became Fourth Vice-President; in 1874 he became First Vice-President, and in 1880 he was elected President. In an admirable tribute to him the Philadelphia Ledger says:

"Few men ever came to the head of a great corporation better qualified by experience and intimate knowledge of its affairs than did Mr. Roberts to the Presidency of this great corporation. He commenced his lifework at the dawn of its existence. To his knowledge of men and the physical characteristics of the system he added that ripe experience in the details of management which his careful attention to every department in the service had brought to him.

"The cardinal principle of his policy was that the business of a corporation should be carried on by those methods which have been most successful in the lives of individuals: that there should be integrity in all things: economy, not parsimony, in expenditures: provision for the future in prosperous times: ownership of what it is wise to control, and keeping up with the general progress of the times. Acting upon these principles, properties were purchased which had formerly been held under leases, and, as the credit of the company improved and money could be obtained on low rates of interest, this policy was extended to the purchase of obligations guaranteed by the company, which were placed in a sinking fund. Profitless enterprises were either abandoned or the burden was shifted upon those who were benefited by them. The policy thus inaugurated was not carried into effect without much opposition, both at home and abroad; but Mr. Roberts was not a man either to be swerved from his convictions or driven from his place. Under this wise financial policy, which has distinguished his company, its credit rose as high as that of the United States during the period of the greatest business depression the country has ever known."

"His skill as an engineer was fully equaled by his abilities as an administrative officer and his genius as a financier. His judgment on questions of finance was notably sound and his associates frequently deferred to him in instances where at first he had stood alone in regard to deciding the policy of the company, in transportation matters connected with the trunk lines and in other grave questions bearing upon the vast interests of which he was the controlling spirit."

Snow-Flanger Operated by Air.—Lake Shore Michigan Southern Railway.

BY OSCAR ANTZ.

The earlier forms of snow plows, which were pushed ahead of the locomotive, were, as their name indicates, a contrivance for cutting into the snow and pushing it to one or both sides of the track. They were made of wood, sometimes faced with iron. Even at the present day, this style of plow is used to a great extent, some in their crude form and some of modern build on more scientific lines. Modern ingenuity has put in the field a number of so-called plows whose principle is to virtually dig out the snow and force it through the machine by centrifugal force out to the side of the roadbed, the power being obtained from an independent engine placed on a car which is pushed ahead of the locomotive.

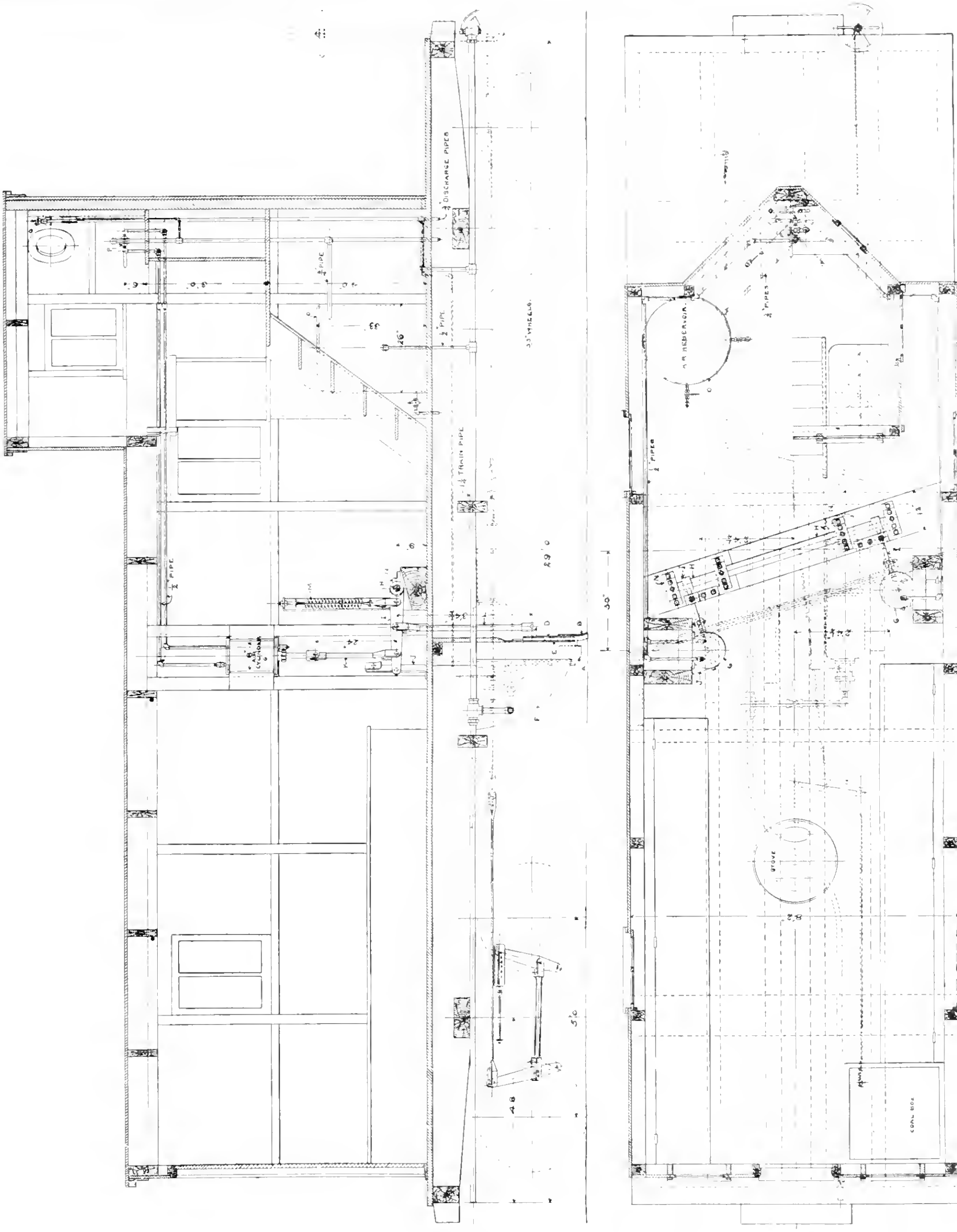
These centrifugal plows, as well as the push plows mentioned, do not, however, take the snow from below the surface of the rail, and this remaining portion, if left in place, forms a good nucleous for a blockade during following storms. A light fall of snow does not always warrant the sending out of the regular plow, and it is for these reasons that a scraper or flanger is used. This is sometimes combined with the snow plow proper, but it is often advisable to have it on a separate car.

A flanger consists of a set of knives of iron or steel, suspended below the body of the car, capable of being raised and lowered, and of such shape as to remove the snow between the rails for about a foot or so from each rail, and also to cut it down slightly on the outside of the rails.

It will be seen that a scraper as described cannot be used where there is anything on top of the ties between the rails, such as at switches, crossovers, street crossings and cattleguards, and provision must therefore be made to raise and lower the scraper as required. This has usually been done by hand, several men on the end of a long lever being usually employed for the purpose. Now it is not unusual to operate the knives of a flanger by compressed air.

The plans shown herewith are taken from a flanger recently constructed by the Lake Shore & Michigan Southern Railway at their carshops in Cleveland. As is usually the case with equipment of this character, this flanger was constructed from an old car, a flat car having been used and the necessary parts added to it. Figs. 1 and 2 represent the plan and sectional elevation and Fig. 3 a cross-section looking towward the front of the car, showing the arrangement of the operating mechanism.

The flanger knives, shown in detail in Fig. 4, consist of five pieces of ½-inch plate steel, *A*, *B* and *C*, which are cut out as follows: Over each rail, the knife *B* is cut out 5 inches wide and 4 inches deep, the outside knives *AA* are 2½ inches shorter than knives *B*, and the center knife *C* is 2½ inches shorter than *B* and tapers still more towards the center. When at the lowest point of their motion, the knife *B* projects 3½ inches below the surface of the rail between the rails, has a ½-inch space between top of rail and bottom of cut-out part and a space of about 1 inch on each side. The knives are made of five pieces, as shown, partly for convenience in manufacture and partly for easy renewal of worn parts. They are riveted or bolted to a piece of ½-inch steel plate, *D*, 15½ inches wide, which is provided with two sets of lugs, to which are connected the rods,



SNOW FLANGER OPERATED BY AIR.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.—Figs. 1 and 2.

which raise and lower it. This plate hangs against pieces of ⅝ by 2-inch iron riveted to another plate, *E*, and it is guided and prevented from moving away from these bearing pieces by bars of 1¼-inch round iron bent in U form, with ends drawn down to 1 inch, forming shoulders, which are fastened to the plate *E*. Slots in plate *D*, in which the U-bolts work, allow it to be raised and lowered. Plate *E* is 21 inches wide, of ½-inch steel and is bolted to cast-iron brackets *F* (see Fig. 2), which in their turn are securely fastened to the bottom of the sills of the car, one to each sill, the bevel on the front face being such as to give the plate *E* an inclination of 30 inches in the width of the car. The space between the top of plate *E* and the bottom of the floor of the car, is filled

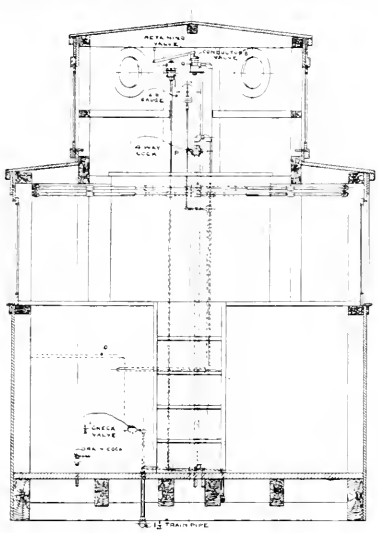


Fig. 3.—Cross-Section of Flanger.

in with wood, to prevent the snow from getting over the plate and back on the track.

The raising and lowering device consists of two 8-inch cylinders *GG*, fastened securely to the sides of the car, at a proper height from the floor and connected to the knives below the car through a series of rods and levers. A pair of ordinary 8-inch freight brake cylinders were used, new heads being made, and the cylinders arranged to be double-acting. The leakage groove in the cylinders are closed up by chipping them out in dovetail shape and driving in pieces of copper. Both cylinders are drilled and capped for ½-inch pipe.

The connections between the pistons and flanger knives are made by using the standard M. C. B. air-brake clevises and pins, the body of the connections being 1¼-inch diameter. A shaft, *HH*, extends across the car parallel to the flanger knives, and to it are fastened the two levers *II*, by being shrunk on and keyed; these levers have drilled in them four holes each, the outer one being used to hold the levers and through them the flanger knives in the highest position, while the car is being run over the road when not in use, brackets *JJ* bolted to the floor of the car being provided to hold the pins. The cylinder connections *KK* are attached at a point 21 inches from the center of the shaft and the connection to the knives, *L L*, 12 inches from the same point, thus giving the knives a motion of a little over 6 inches for the 12-inch stroke of the piston. Close to the shaft is another connection for a spring *M*, which is strong enough to raise the weight of the flanger knives and all attachments on the lever, thus insuring their raising out of danger should the air supply give out suddenly. The shaft *HH* is square at its central part, to provide a bearing for a wrench which is used for operating the mechanism by hand should there be no supply of air to be had. The shaft works in four babitted boxes *NN*, fastened to the block of oak, extending across the car.

The air supply is taken from the train-pipe through a ½-inch pipe provided with a check valve and is stored in a reservoir *OO*. The check valve closes when the pressure in the reservoir exceeds that in the train pipe, which is the case when the brakes are applied. It has been found that a ½-inch pipe will feed a sufficient amount of air to the reservoir to work the flanges continually and it is not so large as to reduce the train-line pressure sufficiently to apply the brakes, as long as the air-pump is attached and running. From the reservoir the air is carried to the four-way cock *PP* by a ¾-inch pipe, and is distributed by this cock to the cylinders.

The four-way cock has ports to the air supply, the atmosphere and the top and bottom of the two cylinders. The connections are arranged in such a manner that when the handle is thrown up the pistons in the cylinders, and with them the flanger knives, will also move upward, and when thrown down they will be lowered, so that the operator need never be at a loss to know in what position the knives are nor how to move the handle to operate them. The connections from the four-way cock to the cylinders are of ½-inch pipe.

The pipes leading into the cylinders at top and bottom are fitted with plugs through which oil can be introduced and moisture drawn off. The discharge pipe from the four-way cock is ¾ inch, and is led down through and below the floor of the car.

The general arrangement of the car is about as follows: The operator stands on a platform raised about four feet from the floor of the car, which is reached by a stairway. A kind of cupola or lookout is built over this platform about three feet higher than the roof, provided at the sides with sliding windows and at the back with stationary ones. The front is on an angle on each side toward the center, and is sheathed solid, with the exception of two circular windows. At the center of the front is a 3 by 12 inch plank extending from floor to roof, and into this are framed the sides and roof of the cupola. On the back of this plank, in front of the operator, are a gage indicating the pressure in the reservoir, a conductor's valve and a pressure retaining valve. A shelf is provided in front of the operator, over which the four-way cock is placed, the space below the shelf being enclosed. The conductor's valve *Q* is connected to the train-pipe in the usual manner, and discharges down through the floor. The old style valve is used, the rope being carried back the length of the cupola, to be within easy reach at all times.

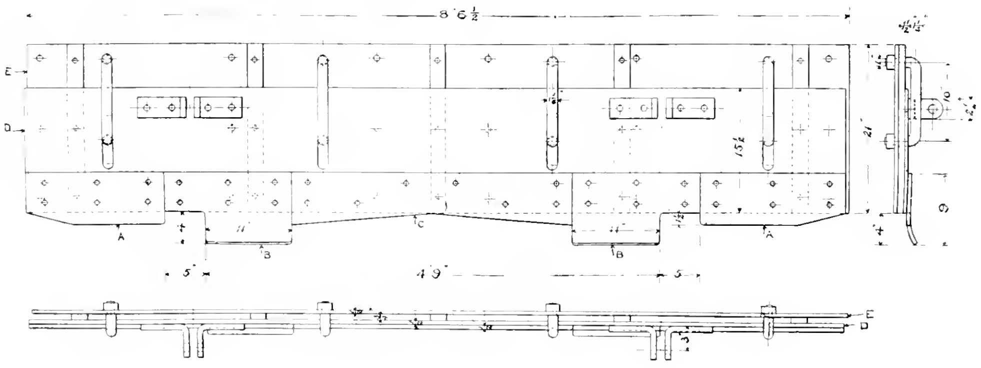


Fig. 4.—Knives of Flanger Operated by Air.

A cushioned seat is provided at each side of the cupola, and in the body of the car, seats with lockers underneath for tools, etc., are arranged for the attendants. A stove provides bodily comfort and sliding windows on the sides and ends furnish light and, when necessary, ventilation.

The car is provided with air brakes, arranged in the usual manner, with brake shaft at one end.

The trucks under the car have inside heavy iron brake beams, and all the parts are kept as high as possible above the rail. The car is fitted with the stands and draft gear of the road and has automatic couplers.

This flanger has been in use since the beginning of the year and has given good satisfaction, the knives being raised or lowered in about two seconds.

American Society of Civil Engineers.

The annual meeting of this society was held in New York on Jan. 20. The officers elected were President, Benjamin M. Harrod, New Orleans; Vice-Presidents, George H Mendell, San Francisco, and John F. Wallace, Chicago; Treasurer, John Thomson, New York; Directors, Rudolph Hering, New York; James Owen, Newark, N. J.; Henry G. Morse, Wilmington, Del.; Benjamin L. Crosby, St. Louis; Henry S. Haines, Atlanta, Ga.; Lorenzo M. Johnson, Eagle Pass, Tex.

The membership of the society on Jan. 1 was 2,018. The site of the new society house in New York was purchased in 1896 for $80,000, of which $.0,000 in cash has already been paid. From competitive designs for the building, that of Mr. C. L. W. Eidlitz was selected and in December the contract was let for $86,775. The work of excavation, costing $4,500, had been completed and paid for at the time this contract was let. Nearly $20,000 in subscriptions toward the cost of the new house have already been received, and altogether the society has already spent over $32,000 on the house, part of the funds being taken from its savings of past years. The balance in the treasury is $11,456.

The report from the sub-committee of the International Committee on Tests of Steel and Iron will not be forthcoming for several months. The report of the Committee on Units of Measurement will be made at the summer meeting.

The Board of Directors reported on the advisability of appointing a committee to revise the methods of making cement tests. It found reasons for and against such a course, but felt that if the committee was appointed its work should be confined to the methods of testing and should not include specifications for cements. The matter will be submitted to letter ballot.

On Jan. 21, the members of the society visited the works of the new Croton Dam at the invitation of Mr. F. Teley, Chief Engineer of the Croton Aqueduct Commission. The New York Central furnished a special train to Croton, from which point the party was taken to the site in carriages.

The work of excavation and construction excited much interest. The dam is built on rock, the foundation of which is gneiss on the northern side and limestone on the southern side, the point of meeting being under the location of the old river-bed. The disintegrated rock at and near the surface had to be removed to a considerable depth in order to secure a sufficient foundation. The dam is to be built mostly of masonry with an earth embankment on the south side. The spillway over which the water is to flow is placed and partially built on the northern hillside, where a channel has been excavated in the rock for the purpose.

The necessity of securing a firm foundation for the dam has caused a very large excation, which, owing to the poor quality of the rock, has extended to a general average of over 80 feet, with occasional depths of 100 to 110 feet below the original bed of the river. About 40,000 cubic yards of masonry are now laid in the main excavation. In order to protect the excavation from the river, a channel has been excavated on the north side, and the river is diverted by temporary dams built above and below the work and connected with the channel wall. The width of the dam at the lowest point is 200 ft. The height above the old bed of the river is 160 feet. The height above the lowest point of the foundation is 270 feet, the length of the masonry part of the dam is to be 700 feet, and the length of the embankment on the south side, nearly 400 feet.

For removing the material excavated the contractors, Messrs. Coleman, Ryan & Brown, erected three cableways over the site. The cables are two inches and 1,400 feet long from anchorage to anchorage and are stretched across the valley at a height of about 175 feet above the river. They are used not only to take away the material but also to place the stones entering into the masonry, which are quarried about 1½ miles up the river and brought to the site on a contractor's railway. Trenton and Lidgerwood cableways are employed and their work was highly praised by those who saw them in operation.

Lunch was served at Croton and on the return trip the special train passed over the new drawbridge and viaduct in Park avenue. It was the first passenger train to pass over the structure and at the bridge the train was stopped and the party inspected it, Mr. Katté, Chief Engineer of the road, giving the members any information desired. In a recent account of this enterprise the New York Sun says:

"The new bridge is the first four-track drawbridge ever constructed, and is the largest of the kind in the world. It is 400 feet long and weighs 2,500 tons. The drawbridge is 58 feet 6 inches wide from center to center of outside trusses, and is carried on three very heavy trusses. Between the central and each of the two side trusses is a clear space of 26 feet, which permits the passage of two sets of double tracks. The floor is corrugated, and the rails are bolted to it on steel tie-plates. The trusses of the drawbridge span are 64 feet in the center and 25 feet at each end. At the highest part of these trusses is situated the engine-house, which contains two oscillating double cylinder engines, which turn the draw, and can be worked together or separately, so that if one should break down at any time the other can do the work. The bridge crosses the river at an angle, and its shore piers are built withn the channel line, so that when the draw is open it leaves the whole width of the river clear, except the space taken by the central pier.

"The Harlem River, having been declared by Congress a ship canal, the Secretary of War has issued orders that all tugs and barges shall joint their smokestacks and flagpoles, to enable them to pass under the bridge while it is closed. He has also ordered that the bridge shall not be opened between the hours of 7 and 10 o'clock in the morning, and 4 and 7 in the afternoon, except for police, fire or government vessels, the hours named covering the great business traffic in and out of the city, the important through trains as well as the principal suburban trains arriving and departing during those hours. Above and below the Harlem the tracks are carried on a steel viaduct. A new station is being built at 125th street. This will occupy the whole block from 125th street to 126th street, under the viaduct. The cost of the work that has already been done, up to Feb. 1, is $1,687,208, and of this the bridge alone has cost about $700,000."

Pneumatic Grain Elevator on the Danube.

Steamers loading with grain at ports on the River Danube frequently have to be lightened before they can get to the ocean, because of the sudden changes in the state of the river. Grain taken out of a steamer under these conditions is loaded on barges and by them transported to the river's mouth, where it is again placed on the steamer. This work of transfer was formerly done by hand, but is now accomplished by a pneumatic grain elevator. Engineering says that the first vessel carrying one of these elevators is built entirely of steel, and is 130 feet long by 22 feet beam by 11 feet deep. The machinery consists of two multitubular marine type boilers 9 feet 6 inches diameter by 10 feet long, and each boiler has two furnaces of 2 feet 4½ inches diameter. The pneumatic engines are of the horizontal type, having a high-pressure cylinder 22 inches diameter and a low-pressure of 42 inches diameter. The stroke is 4 feet. There are four air cylinders, each 38 inches in diameter, and the engine will bevelop 470 indicated horse-power. The air is exhausted by the pneumatic engine from two large steel tanks or receivers placed at 30-foot centers amidships of the vessel, and carried on steel towers. The extreme height of these structures is 61 feet above the water level, and is sufficient to allow of the grain running by gravity through the shoots into the largest ocean vessel. The suction pipes through which the grain is lifted from the barges into the receivers can be attached on either the port or starboard side. The grain when lifted falls to the bottom of the receivers, and the air is separated and drawn off from the top. The grain passes from the receivers into boxes which are divided into two air-tight sections, and oscillate on pivots, so that one side is being filled with grain as the other is discharging its load, the weight of the grain on one side or the other giving the necessary see-saw movement to the apparatus. The grain then falls on to iron trays resting on pivots fore and aft, so that it can be delivered down the incline given to the trays on which-

Elevation of Reconstructed Grand Central Station, New York City.

ever side may be desired. The exhaust air, after leaving the pneumatic cylinders, is delivered into quieting chambers placed at the extreme ends of the boat, and thence escapes without noise into the atmosphere. The elevator will transfer 140 tons per hour at a very low cost.

Reconstruction of the Grand Central Station in New York City.

For some time past plans have been under consideration for the re-arrangement and enlargement of the Grand Central Station in New York City, and recently the whole matter was put in charge of Mr. John M. Toucey, General Manager. Mr. Walter Katté, Chief Engineer of the road, and Mr. Bradford L. Gilbert, architect, have respectively taken care of the engineering and architectural work.

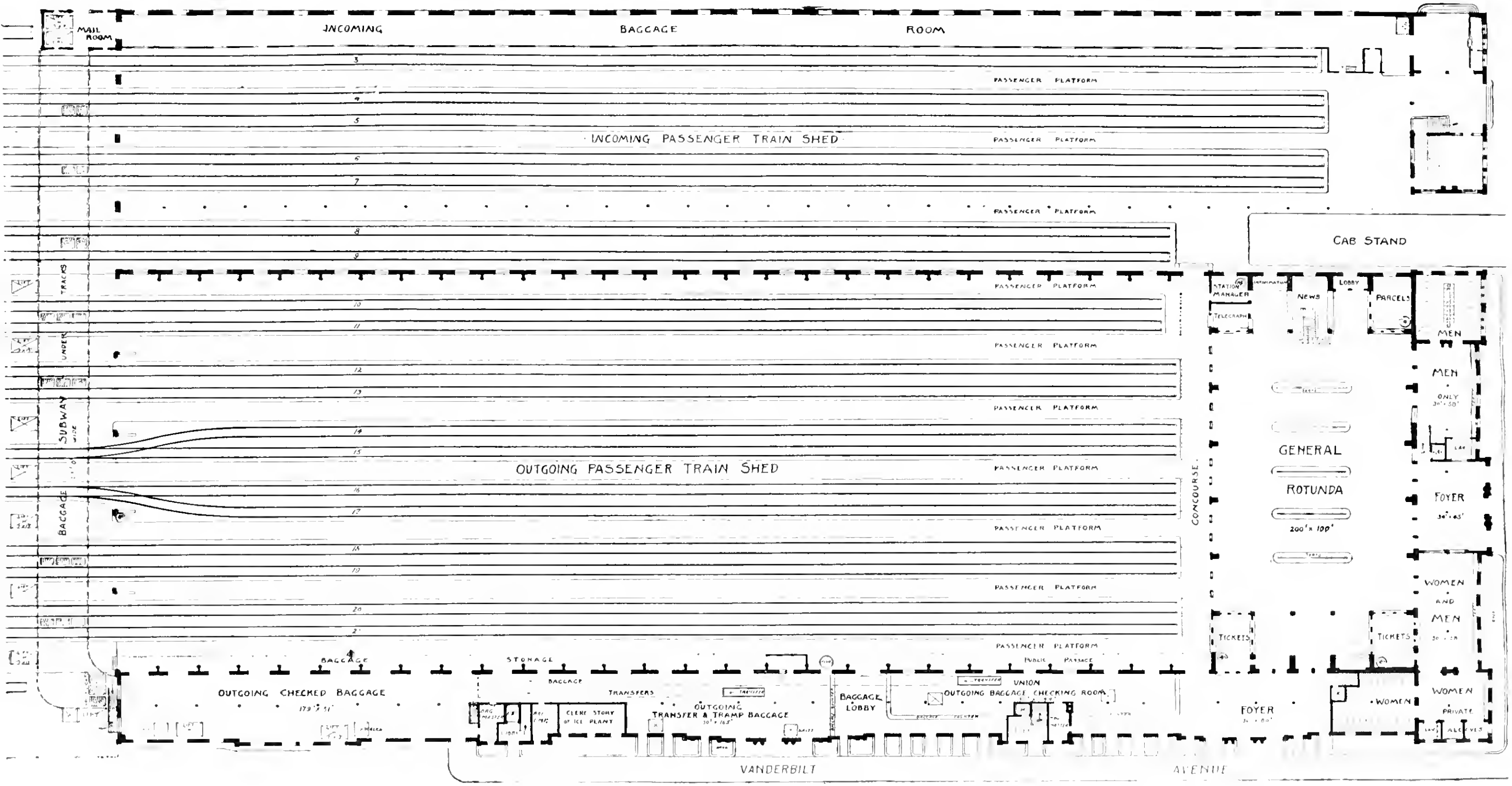
This well-known station was built 27 years ago, and since its erection the traffic of the three roads entering it has grown enormously. At present the number of passengers handled, in and out, is in round numbers eleven and one-half millions yearly. The building has at present three waiting-rooms, one for each road, and the New York Central room in particular is so situated as to be convenient to only a few of the tracks in the train-shed. The plans for the reconstruction provide for the consolidation of all the passenger business into one large waiting-room with its auxiliary baggage-rooms, ticket offices, ladies' rooms, smoking-rooms, toilets, etc. This would in itself increase the number of people that can be handled daily at the station, but further provision is made for their comfort by largely increasing the floor area of these rooms.

The general waiting-room is to be located at the south end of the present train-shed (see plan), and will be 100 feet wide and 200 feet long, making what is to be the largest waiting-room in the world. Its roof will be arched and will be constructed of steel, iron and glass. The room will have an entrance on Forty-second street through a foyer 34 by 45 feet, one on Vanderbilt avenue through a foyer 30 by 60 feet, and through vestibules from the incoming station on the east side of the room. Opening off the large room is a smaller general waiting-room 30 by 58 feet. Other rooms are a ladies room 34 by 34 feet, ladies' toilet 20 by 30 feet, smoking-room 30 by 58 feet, gentlemen's toilet 35 by 35 feet and ticket-offices with 20 windows. The combined waiting-rooms of the station, as it is to-day, have a floor area of about 12,000 square feet; the reconstructed station will have 28,000 square feet, exclusive of toilet-rooms and platforms.

The baggage-rooms are to be along the west side of the train-shed, on Vanderbilt avenue. There is to be an outgoing baggage-checking room 30 by 144 feet, an outgoing baggage-transfer room 30 by 165 feet, and an outgoing checked-baggage room 31 by 179 feet. The incoming baggage-rooms are in the station for incoming trains, to the east of the main station, as at present. The three outgoing-baggage rooms mentioned are provided with platform conveyors, by which the baggage is carried under the floor to the basement at the extreme north end of the building, where it will be put on baggage trucks and taken through a subway 25 feet wide, extending under all the tracks. At each passenger platform there will be a baggage lift, to raise the baggage from the subway to the platform.

The office part of the building will also be greatly enlarged. Two stories will be added and the present office floor area of 55,000 square feet increased to 133,000 square feet. A new power plant of 1,750 horse-power will be installed for the electric lighting of the station, offices, train-shed and yards outside. It will also supply power for the baggage transfers and lifts, and for the elevators to be put in for reaching the offices. The heating and plumbing will be new. There will also be an ice plant with a maximum capacity of 40 tons per day.

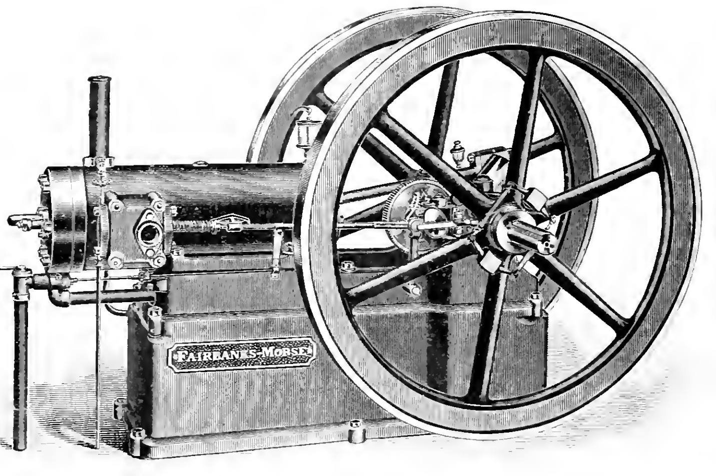
The exterior of the building is to be altered considerably, but Mr. Gilbert's aim has been to combine the new with the old so that it will harmonize completely. The entire exterior of the plain brick walls will be covered with a Portland cement stucco, which will give the effect of a solid, rough gray background, with trimmings of white. The cost of the new work on the building proper, exclusive of the power plant, is placed at about $500,000, but the cost of the alterations of that portion of the present building which is to be utilized are not stated. When completed it will be one of the finest stations in the world in all its appointments.



GENERAL PLAN OF RECONSTRUCTED GRAND CENTRAL STATION, NEW YORK CITY.

The Fairbanks-Morse Gas Engine.

The gas and gasoline engines made by Fairbanks, Morse & Company, of Chicago, have earned for themselves an excellent reputation for economy and durability. These engines run at slower speeds than is customary in gas engine practice, the speed of a 10 horse-power engine being 225 revolutions per minute, a 20 horse-power engine 175, a 50 horse-power engine 160, a 75 horse-power engine 150 revolutions, etc. This moderate speed, accompanied by simplicity ot design and substantial construction, gives great durability to the engine.



The Fairbanks-Morse Gas Engine.

It is made in sizes up to 100 horse-power with a single cylinder, which is as large as any made in this country in which the power is generated in one cylinder only. The two horse-power engine is vertical, but all other sizes are of the horizontal type. The engraving herewith shows one of these gas engines, the view being taken of the side on which the valve gear is located. The simplicity of the engine will be the more apparent when we state that there is no mechanism on the other side of the cylinder except a starter, to which we will refer later.

The engine operates on what is generally called the "Otto" cycle that is, there is one working stroke in every two revolutions. There are only two positively operated valves to the engine and they are both of the poppet type. One is the exhaust valve, located within the rectangular chamber on the side of the cylinder, and the other is the gas valve, directly under the cylinder head. A suction valve in the cylinder head admits air on the charging stroke. These valves are water-jacketed. There is but one cam, which, by means of a straight rod carried in suitable guides, operates the exhaust value and also controls the gas valve.

The governor is clearly seen in our illustration. It is attached to the hub of the flywheel and acts directly on the exhaust valve. When the speed of the engine rises slightly above normal the governor moves the short horizontal lever, one end of which is seen in front of the cam, and this end engages the rod operating the exhaust valve at a time when that valve is open, and prevents the valve from closing. At ths same time the connection between this rod and the gas valve keeps the latter closed until the speed falls to normal, when the governor releases the valve gear. Consequently, no charge enters the cylinder, and the exaust valve being open, there is no useless compression to add to the friction of the engine. It will be noticed that the cam for operating the valves is placed on a shaft driven from the main shaft by two to one geariog, and that the entire governing mechanism is right at this point, thus making a compact arrangement.

The ignition is accomplished either by an electric spark or by a hot tube. By careful attention to details both of these methods have been made unusually satisfactory. Our illustration shows the hot-tube ignition,

The ease with which the engine can be started is another of its good features. On the other side of the cylinder from that seen in our engraving is a small hand pump by which a charge of gas and air can be pumped into the engine cylinder. Before this is done a detonator plug is removed from the cylinder and the end of a match stuck in it, after which it is replaced. When the cylinder has been charged, a smart rap with the hand on the knob of the detonator lights the match and explodes the charge, giving power enough in the cylinder to start the engine under a two-thirds load. This starter can be used with either the electric igniter or the tube igniter, as it is entirely independent of them. This allows the starter charge to be fired at the most desirable time, giving the best results in starting.

It will be noticed that the cylinder is unusually long. The reason for this is that a very long piston is employed, and it is packed with five rings.

The gasoline engine is as simple as the gas engine, and in a 20 horse-power engine with gasoline at eight cents per gallon, will give a horse-power for about four-fifths of a cent per hour.

It is claimed for these engines that they are unusually economical under light loads, and users of gas engines know this to be an important point. This claim is based in part on the absence of compression when the governor has prevented charges from entering the cylinder.

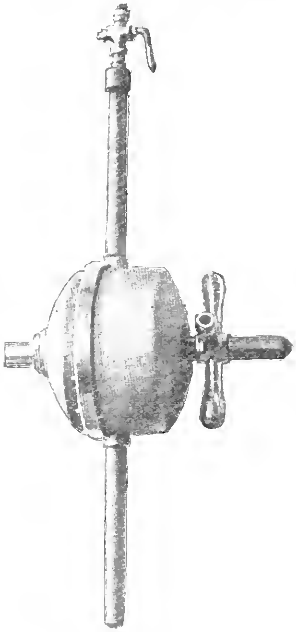
These engines are built for general power purposes, and are also adopted for special uses. For water pumping they are directly geared to a pump mounted on the same base, making a self-contained plant.

The Boyer Piston Air Drill.

In the varions applications of compressed air in shops motors of the rotary type have thus far predominated, but with the increasing demand for small motors there has arisen a dissatisfaction with the rotary because of its extravagance in the use of air. The piston air drill recently perfected by Mr. Boyer and placed on the market by the Chicago Pneumatic Tool Company therefore makes its debut at an opportune time. Like all of Mr. Boyer's productions, it is ingenious and designed on original lines, while the details have been worked out with skill and painstaking care. In the accompanying illustrations we give a view of the motor complete, as designed for light work, such as tapping staybolt holes, reaming, drilling, etc.; a second view shows the motor taken apart separated sufficiently to make clear the method of construction.

The motor has three 2-inch cylinders, seen under the arms of the triangular piece in the middle of Fig. 2. Their pistons are connected to a single crank fitted with ball bearings. The crank is fixed, however, and the cylinders travel around it, being carried on the triangular piece already mentioned. A small pinion (not shown) is attached to this triangular member and meshes into the two gears shown in that part of the casing to the left in Fig. 2. These gears also mesh with the internal gear seen on the casing and are journaled on a frame under them which carries the drill chuck. Thus the cylinders revolve bodily on their framework and the gears seen revolve within the casing on a frame to which the drill chuck is attached, but at a much lower speed than that of the cylinders. With 100 pounds air pressure and the gearing down, the power at the spindle is considerable—all that can be used in a hand drill. It is claimed that the motor will drill a 2½-inch hole.

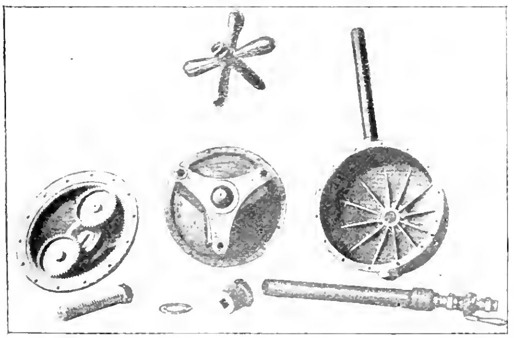
In addition to its economy in the use of air—some tests place



The Boyer Piston Air Drill - Fig. 1.

its consumption at one-fourth that of a rotary—the motor has the advantages of being in perfect balance and weighing complete only 26 pounds. The balance is said to be so perfect that even at speeds of 1,500 revolutions per minute the vibration cannot be felt.

The cylinders are made of machine steel, their frames of cast steel, the gears and pinions of cast steel, the feed screw and star



The Boyer Piston Air Drill—Fig. 2.

of steel, and the casing of malleable iron or bronze, so that it is evident the best of materials enter into its construction. The workmanship is equally good.

The uses of such a motor are too well known to require enumeration on our part. Larger sizes of the motor can be adapted to many power purposes requiring either fixed or portable motors. The offices of the Chicago Pneumatic Tool Company are in the Monadnock Block, Chicago, Ill.

New Publications.

THE STEAM NAVY OF THE UNITED STATES. By Frank M. Bennett, Past Assistant Engineer, United States Navy.

We have before us a large octavo volume of 950 pages bearing the above title. It is published by Warren & Company, 416 Wood street, Pittsburgh, and is further described on its title page as "A history of the growth of the steam vessel of war in the U. S. Navy, and of the naval engineer corps." Value and embellishment are added by a great number of illustrations, many of them full-page halftone plates, showing types of ships and machinery, old and new, and portraits of distinguished engineers.

As a history of the influence steam and machinery have exerted upon naval tactics and methods the volume is complete, and, while of deep interest to all reading and thinking men now, will serve in the future as a mine of information to readers and historians who may desire to know the details of the complete transformation that has come upon all navies during this century. Previous naval histories and accounts of naval operations, particularly those written by officers of the sailor branch of the navy, have kept the engineer and the idea of machinery in the background, as though sailors and sails were the only elements in the navy. This unwarranted slight is fully overcome by the array of facts presented by our author, who shows that the engineer, fighting against the very element that should have welcomed him, has not only brought the navy into its condition of efficiency, but has also enabled his antagonists to achieve professional honors by means of the innovations he forced upon them.

The first steam war-vessel ever built was an American invention. This was the *Demologos*, known on the navy list as the *Fulton*, designed and built by Robert Fulton in New York during the war of 1812. This ship was 156 feet long, 56 feet beam, and of about 2,500 tons displacement; she mounted 20 heavy guns and was propelled by a central paddle-wheel driven by a single engine and boiler of primitive type. No masts or sails were provided in Fulton's plans, the vessel being in his intention a "steam-battery," and this, by the way, is all that a modern battleship is when stripped of the refinements of science that are not essential to it. When the *Fulton* was nearly completed (in 1814) Capt. David Porter returned home from his disastrous cruise in the *Essex* and was assigned to the command of the new steamer. Porter was a fine old seaman of the wooden age and had no faith in steam; he caused heavy masts to be stepped in the *Fulton* to carry lateen sails and had the ship's sides built up to form walls to protect the sailors who thus became needed to handle those sails. The original and sensible intention was to have an engineer's crew for the working of the ship and artillerymen for the battery, but Captain Porter did not propose to allow anything to float without sails and sailors. Thus at the first possible opportunity did the sailor seek to nullify the efforts of the engineer, and this antagonism crops out prominently throughout the whole history of the application of steam to naval purposes. One of its most modern demonstrations is the influence that put sails upon the *Chicago* and tried to put them on the *Maine*.

The *Fulton* unfortunately was not completed until peace with Great Britain had been declared, and the opportunity of testing her in battle against sailing ships was therefore lacking. She had some very satisfactory steam trials during the summer of 1815 and was then laid up at the Brooklyn Navy Yard as a receiving ship. In 1829 her magazine blew up, completely destroying her and killing many people.

In 1835 the Secretary of the Navy unearthed an act of Congress of 1816, authorizing the construction of another steam battery, which act had been ignored by the worthy commodores composing the Board of Navy Commissioners. After considerable correspondence between this board and the Secretary work on the new vessel was begun at the New York Navy Yard. This vessel was also named *Fulton* and was completed in 1837; she was 180 feet long, 35 feet beam and of about 1,200 tons displacement. Independent side-wheels each driven by a separate engine supplied the motive power, the engines being located on the upper deck over the boilers. A speed of 12 knots was maintained easily, and her Captain, Mathew C. Perry, reported that she was a match for any number of sailing ships of war. A picture of her which the author presents shows a barkentine-rigged steamer not unlike in appearance the few side-wheel sea-going steamers that still exist. A page of her engine-room log is also reproduced and is a genuine professional curiosity.

Two much larger side-wheel steamers were begun in 1839 and completed in 1842; these were the *Mississippi* and *Missouri*, sister ships 229 feet long, 40 feet beam and of about 3,200 tons displace-

ment, carrying 19,000 square feet of canvas to their great detriment. The *Missouri* was burned in Gibraltar in 1843 owing to the carelessness of a storeroom keeper who broke a demijohn of spirits of turpentine. The side-wheel gunboat *Michigan* was built at this same period, the work being done in Pittsburgh and the parts carried overland to Erie, where they were put together and the ship launched in 1843. She was the first iron vessel in the navy and is still in service with her original engines.

Considerable experimental engineering was indulged in by the Navy Department during the forties. Lieut. W. W. Hunter, of the navy, patented a submerged horizontal paddle-wheel for propelling ships and obtained authority from the department to carry out his ideas. Three steamers—the *Union*, *Water-Witch* and *Allegheny*—were built according to his plans and were all failures, as every one at all familiar with mechanical laws knew they would be. Mr. Hunter's wheels were well designed for churns, but they were not adapted for propelling purposes. While the Hunter wheel fallacy was being tried, a real engineer—John Ericsson—was carrying to success his system of submerged propulsion by the use of a screw propeller. The naval steamer built for this experiment was the *Princeton*, the first screw-propelled war vessel ever built, and as her success put an end to experiments with methods of propulsion and made it possible to locate machinery below the water line she is justly credited with being the germ of our steam navy. Ericsson's connection with this famous vessel and his troubles with Captain Stockton of the navy, who tried to appropriate credit for Ericsson's inventions, are told in detail. During this experimental period also was begun that famous ironclad construction known as the "Stevens Battery" the history of which is carefully told.

Sailing ships were used at first in the Mexican war, but the superiority of steamers was so obvious that the Navy Department eventually employed a considerable number of small steam vessels acquired by purchase or charter. This was brought about chiefly by the efforts of Capt. M. C. Perry, who was about the only Captain of the period who did not despise steam. At the close of that war a systematic programme of building a steam navy was inaugurated. The first steamers thus created were the *Powhatan* and *Susquehanna*, with side wheels, they being enlarged and improved *Mississippis*, but thereafter the screw propeller came into general use. The author describes in detail the ship and machinery construction from 1850 to 1860, which gave us the *Merrimac* class of screw frigates, and the *Hartford*, *Dacotah* and *Narragansett* classes of screw sloops, 18 fine steamers in all, to which number may be added six smaller steamers purchased and armed in 1859 for the Paraguay expedition. One of the large screw sloops—the *Pensacola*—had remarkable expansion engines, designed by Mr. E. M. Dickerson, which are technically described by our author in the body of his work and humorously described in an appendix entitled "Uncle Sam's Whistle and What it Costs."

Warship construction during the Civil War assumed such magnitude that the task of describing it is great, but Mr. Bennett has patiently gone through all the records and arranged for his readers a connected and illustrated account of all the types of ships then called into being, from the little "ninety day" gunboats and "double-enders" up to the big cruisers. As a matter of course the monitors and other mastless ironclads, essentially engineers' ships, receive special description, and considerable space is given to the construction and trial trips of the swift cruisers brought into existence by the conditions of war. When the war ended the navy fell into a disgraceful state of decay, interrupted only by the irregular and illegal shipbuilding efforts of Mr. Secretary Robeson during the seventies. The manner in which he "repaired" old sailing ships into steam sloops, and transformed decayed wooden monitors into iron turret-ships has always been a mystery to the public and even puzzled the Congressional Committee that investigated his administration, but we think Mr. Bennett has condensed from the mass of documents in the case as clear and concise a statement of the facts as has ever been given to the public. The revival of interest in the navy that led to the beginning of its rehabilitation, the proceedings of the advisory boards, and the progress of the new navy are excellently described in the concluding chapters of this invaluable book.

The foregoing outlines the scope of this work so far as the history of the growth of steam in the navy is concerned. Woven in with the story of the steamship is the story of the man who made the steamship possible—the engineer. When the second *Fulton* was being built the Board of Naval Commissioners was driven to the sore extremity of asking the Secretary of the Navy for an engineer to furnish advice and superintend the construction of the machinery. After some delay Mr. Chas. H. Haswell, of New York, was, in February, 1836, appointed to "furnish draughts" to the board for a term of two months, for which service it was specified he should receive $250. In July of the same year he was appointed Chief Engineer of the *Fulton*, thus becoming the first person who held the position of engineer in the navy. About a year later Captain Perry took command of the *Fulton*, and at once gave attention to the question of organizing an engineers' force, there being then no assistant engineers and no firemen for the ship, and no apparent intention on the part of the Navy Board to provide them.

Perry's recommendations were not heeded until the vessel was ready for steam and he reported his inability to move her without the desired force. Regulations on the subject were then issued and Perry appointed four assistant engineers, in conformity with their provisions, but the appointments were revocable at the will of the Commander. Engineers for other vessels were appointed in the few following years in this same temporary manner, until, in 1842, Congress, at the instance of the engineers themselves, created the Engineer Corps as a recognized arm of the naval service and specified its members to be officers and that Chief Engineers should be commissioned by the President. The same act created the office of Engineer-in-Chief of the Navy. Mr. Haswell became Engineer-in-Chief in 1844 and the next year performed an act of lasting benefit for the corps by causing all engineers in the service to undergo a competitive examination, from the results of which they were arranged in grades in order of proficiency.

By orders issued by the Navy Department and by Acts of Congress from time to time the requirements for admission and promotion in the corps and the pay of its members have been gradually improved. In 1866 the admirable Cadet-Engineer system at the Naval Academy was instituted by Congress, the history of the inception, development and destruction of this system being told in one of the interesting chapters of the work. The same year First and Second Assistant Engineers became commissioned officers by Act of Congress, and in 1870 the grade of Third Assistant was merged into that of Second Assistant. The titles of First and Second Assistants were changed in 1874 to Passed Assistant and Assistant Engineer respectively.

By persistent warfare with the sailor-officers of the navy the engineers have overthrown sentimental bigotry regarding sails. Such ships as the *Princeton*, *Monitor* and *Wampanoag* were typical, and were the forerunners of military factors that are now combined to make the fighting leviathan of to-day.

The engineers of the navy have thus realized their conception of the proper type of fighting ship, but they have not yet succeeded in gaining official recognition for themselves. They are considered as "non-combatants." In one of Mr. Bennett's chapters he presents data taken from the files of the Surgeon-General's office from which it appears that during the four years of the Civil War 115 members of the Naval Engineer Corps were killed in battle or died of wounds or disease incident to the service. A tabulated list gives further the names of over 100 naval engineers who, during the same period, were killed or injured by violent means, a majority of them by gunshot wounds. Non-combatants, indeed!

THE HOME STUDY MAGAZINE.—The Colliery Engineer Company, Scranton, Pa., proprietors of The International Correspondence Schools, announce that commencing with the February issue the name of the journal, Home Study, which they publish, will be changed to Home Study Magazine; the page will be reduced to magazine size, but the number of pages will be doubled. The articles relating to particular branches of industrial science will be grouped in separate issues. Articles relating to Steam Engineering will be published in the February and August issues; those on Plumbing, Heating and Ventilation in the March and September issues, etc. Each issue will contain other articles, but, as a rule, the general reading portion will consist principally of articles on some particular technical subject. More space will be given to the Answers to Inquiries Department. Each issue will also contain a drawing plate with instructions for drawing it, and an effort will be made to adapt the plate to the subject treated in the issue in which it appears. The subscription price is $1.50 a year, but subscriptions will be accepted at 30 cents for any of the two-number editions.

Books Received.

SKETCHES IN CRUDE OIL. By John J. McLaurin, Harrisburg, Pa. Published by the Author.

ANNUAL REPORT OF THE CHIEF OF ENGINEERS, UNITED STATES NAVY FOR 1896. Six volumes. Government Printing Office, Washington.

The Maine Central, the official organ of the Maine Central Railroad, appears this month under a new management, it having been placed under the charge and personal supervision of Col. F. E. Boothby, General Passenger Agent, and it will hereafter be issued from his office. This paper has probably done more to ad-

vertise the State of Maine summer resorts than any other medium, and under Colonel Boothby's charge it will unquestionably prove a greater drawing card than ever in inducing the sojourner to make Maine his permanent summer home. It will, however, be the aim of the new management to make its interests of greater diversity, so that it will reach all classes of travel within as well as without the borders of the New England States.

The February number is devoted to the scenic and tourist attractions of New Brunswick and the Provinces, the Maine Central Railroad forming the connecting link of the all-rail line reaching all parts of New Brunswick, Nova Scotia and Cape Breton.

The March number of the Maine Central is to be devoted to hunting and fishing, and besides the regular circulation to the subscribers, to 17 newspaper agencies, to 50 prominent newspapers, to the principal clubs in every city in the United States, to all the leading hotels, to Maine Central agents and employees, the recreation department of the Outlook and Review of Reviews, among the patrons traveling on the Maine Central trains, to parties from all over the country who write each month to the General Passenger Department for copies containing descriptions of the summer resorts which they wish to visit; nearly 10,000 copies are to be distributed from the Maine Camp at the Sportsmen's Exposition to be held at Madison Square Garden, in New York City, the week of March 15 to 20.

Trade Catalogues.

[In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. These are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

CRANES. The Brown Hoisting and Conveying Machine Company, Cleveland, O., 1897. 90 pages, 6 inches by 9 inches. (Standard size.)

This catalogue contains many half-tone engravings of various types of cranes made by this company, the cranes being fitted for hand or power, as required. They include traveling cranes, locomotive cranes, jib and pillar cranes, derricks, stationary bridge cranes, steam and electric transfer tables, truck cranes, overhead tram-rails, crabs and winches. Special attention is directed to the electric traveling cranes, and also to the company's very convenient hand traveling cranes adapted for light work. The company also makes pneumatic, hydraulic and steam hoists, which are illustrated and described in this book. The illustrations are nearly all full page, and present a large array of hoisting and transferring apparatus from which a purchaser can make a choice. The company has offices in Cleveland, New York Chicago and Pittsburg.

THE MCKEE BRAKE SLACK ADJUSTER. The Q & C Company, Chicago, Ill., 1897. 32 pages, 6 by 9 inches. (Standard size.)

We have on several occasions made the statement that trade literature often contains the best general information available in the field covered by those particular publications. The pamphlet before us is another excellent example of this truth. Comparatively little space is given to the McKee brake slack adjuster itself, which was illustrated in the pages of this journal nearly one year ago, but the general subject of adjustment of brakes is handled in excellent fashion and information valuable to every air-brake man is given. The meaning of total leverage is first made plain. Then follows a demonstration of the inefficiency of hand adjustment of brakes that should lead railroad officers to realize how much more there is in the problem than the simple question of how frequently brakes must be adjusted by hand if automatic devices are not employed. Brakes may be adjusted alike by hand but they will not remain so and the differences in piston travel, even if not very great, will cause great differences in brake power, particularly with moderate pressures on the one hand or short travels on the other. Then the release of brakes whose piston travels are unequal is not prompt after a heavy application and the longer the train the greater the trouble.

It is a fact not generally known that the piston travel measured while a car is standing still is never as great by an inch or two as when running. The reason for this is brought out and its effect discussed in this pamphlet. Lost travel, false travel, shoe clearance, angularity of levers, necessity of close adjustment, etc., are all considered, and the pages dealing with this subject are worthy of a careful reading.

It is a somewhat remarkable fact that the efforts made to introduce automatic adjusters have done more than anything else to open the eyes of car men and air-brake men to the bad effect of many practices in putting up brakes on cars and in the design and construction of their details. For this reason alone such literature on adjusters, as we have before us, should be widely read. And when we add to this reason another one founded on the excellence of the particular adjuster herein illustrated and described, and our belief that it is the best now on the market, we have explained why we urge our readers interested in air-brakes to send for a copy of the pamphlet.

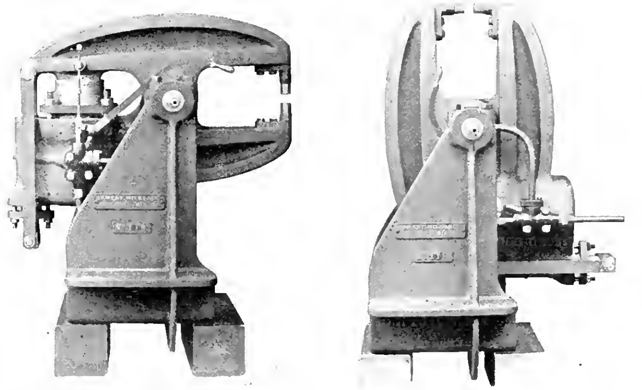
Portable Hydraulic Riveting Machines—Bement, Miles & Company.

The well-known firm of Bement, Miles & Company have built a large number of riveting plants operated by hydraulic power, steam or compressed air, and their line of stationary hydraulic riveters includes machines measuring 60, 72, 84, 96, 108, 120, 144, 172 and 198 inches depth of throat. These larger sizes, particularly the last-mentioned one, whose throat is 16 feet deep, are wonderfully heavy machines. In all these sizes the actual depth of throat is from 2 to 4 inches greater than the nominal depth given above. The company manufacture these machines either with a solid steel frame or with the stake and frame in separate parts bolted together.

The firm has recently designed a new type of machine which is extremely well adapted for some classes of work. We illustrate two styles of these machines; one arranged to revolve horizontally and the other to swing vertically. Either style of machine can be made with any depth or shape of gap required. In both styles the riveter is mounted on a suitable standard or frame and can be revolved about an axis. Through this axis the water pressure is led to the hydraulic cylinder, thus making the water connections quite simple. In each case the cylinder is at the opposite end of the riveter from the dies.

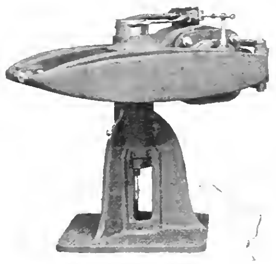
The portable riveters made by this company are in sizes from 2 to 60 inches depth of throat and may be suspended so that the gap will be in either a horizontal or vertical position.

They also manufacture accumulators of all sizes and two sizes of belt-driven pumps. The No. 2 size has a capacity of 8 gallons per minute against 1,500 pounds per square inch pressure when running 100 revolutions per minute. The other size, No. 3, has a capacity of 21 gallons per minute against 1,500 pounds pressure per square inch when running 240 revolutions per minute. The amount



Hydraulic Riveter.—Bement, Miles & Company.

of water and the size of accumulator required for operating a hydraulic riveting plant are governed by the amount of work to be done. Experience has shown the firm that one riveter alone requires a pump with a capacity of 16 to 20 gallons per minute and an accumulator with six-inch ram and six-foot stroke; one riveter and a crane will require a 30-gallon pump and an 8-inch by 10-foot accumulator. Two riveters and two cranes, or doubling the machines, will not require doubling the pump and accumulator; about 50 per cent. increase will be required, say a 50-gallon pump and a 10-inch by 10-foot accumulator, for two riveters and two cranes. For a flanging machine with 28 or 30-inch cylinder, one or two



Hydraulic Riveter.—Bement, Miles & Company.

riveters and one or two cranes, a 100-gallon pump and a 10-inch by 15-foot accumulator will be sufficient. For a large equipment, such as a flanging machine, two riveters, two cranes, two jib cranes and one or two hydraulic punches, there will be required a pump with a capacity of about 120 gallons per minute and a 12-inch by 16-foot accumulator.

The company has built many riveters in which steam or compressed air furnishes the power, and with their wide experience in the building of boiler shop tools of all kinds are prepared to equip plants with high grade machinery exactly adapted to the requirements of their patrons.

An Australian Consolidation Locomotive.

In *Engineering* there appeared recently engravings of a "heavy goods locomotive for the New South Wales government railways," designed by Mr. W. Thow, Chief Mechanical Engineer of that line, and built by Messrs. Beyer, Peacock & Co., Limited, of Manchester. These engravings will be interesting to American engineers, inasmuch as they show the results of experience and study of American engines by an intelligent English engineer and the conclusions which he deduced therefrom. The main features of the engine are American, and many of the details English. As the above title indicates, the engine is of the consolidation type with a Bissel truck; driving wheels, 51 inches diameter; cylinders, 21 by 26 inches; a grate 8 feet 7½ inches long by 3 feet 5½ inches wide. The frames are, however, of the English plate pattern, the plates being 1¼ inches thick. The fire-box is placed between these frames, which permits it being made somewhat deeper than would be possible if it was placed on top of bar frames after the American fashion, but it is not quite as wide as our fire-boxes are on engines of a similar class.

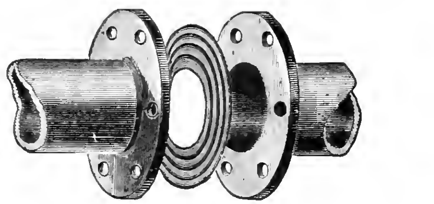
The valve-seats are placed between the cylinders, the valves being vertical and are worked by an Allen straight-link motion. This necessitates bent eccentric rods and a radius rod with a gap in it to clear the front driving axle. The steam passages are very long, and it is thought that in this country the arrangement of steam-chests outside on top of the cylinders and valves, operated by a rocking shaft and ordinary link, would be universally preferred. English engineers almost invariably seem to have an unreasonable prejudice against the use of a rocking shaft. As a matter of fact, there is hardly any working part of an American locomotive which costs so little to maintain or gives so little trouble as a rocker. The truck is distinctly American in design, excepting that Mr. Thow has adhered to his predilections and has used a very small plate frame even on his truck. The steam-chests, being inside, they would come in the way of the truck frame if made in the usual A form. It was therefore necessary to use a single bar for carrying the center pin. This bar is attached to a transverse plate at its front end which does not look like a very secure or strong form of construction.

The springs of the two foremost driving axles are above the boxes, and those over the two hindmost axles are below them. The springs over the front driving axles are connected by a transvere and a central equalizer with the truck. The springs over and below the three rear axles are all connected together by equalizers. The firebox is of the Belpaire type with the crown-sheet slightly arched and inclining downward toward the back. The smallest outside diameter of the boiler is 61¾ inches. The dome is about the middle of the barrel of the boiler and has a safety valve on top. Two other safety valves are placed over the firebox. The latter has a long brick arch below the tubes and extending upward and backward.

Our American builders could, with advantage, imitate the form, size and arrangement of steps ou the back end of the engine, and on the tender adjoining.

Corrugated Copper Gaskets.

We show herewith a corrugated copper gasket that is very successfully used in place of rubber or other destructible materials so generally employed for packing. It consists of thin sheet copper stamped with concentric corrugations. Three to six corrugations are all that are necessary, so that the space within the bolt holes usually determines the width of the gasket. In cases where the flanges are thin, and for this reason liable to bend when the bolts are tightened, it is advisable to extend the copper gasket to the



full width of flange. This will, of course, require the cutting of bolt holes in the gasket.

Connections made with these gaskets will not blow out after continued use, for each corrugation makes the entire circle of the flange, and so long as the contact is kept complete by compression the joint cannot leak. It never blows out like rubber. It may be put in place while steam is leaking through the valve. It answers well on pipes in which steam is alternately on and off, for it is not impaired by the repeated expansion and contraction.

It is made not only in the circular form shown, but can be obtained in elliptical and rectangular shapes, in fact, in any desired shape or size. It is for sale by the U. S. Mineral Wool Company, 2 Cortlandt street, New York, and by the Bourne & Knowles Manufacturing Company, Cleveland, O.

The Gas Exposition in New York.

The Gas Exposition held in Madison Square Garden, New York, last month, was a revelation in at least one respect, namely, the brilliancy and beauty of the illumination of the building. Of course electricity was ruled out of this exposition and yet the lighting was all that could be desired. The Welsbach burner was everywhere in evidence and accounted for the brilliancy of the illumination, which certainly could not have been duplicated with gas 10 years ago.

Gas fixtures and gas stoves without number were to be seen among the exhibits and the various uses for gas in exhibiting and lighting were such that one 8-inch and two 6-inch mains were laid into the building. An illuminated tower 60 feet high, representing the development of gas lighting, stood in the center of the hall.

To our readers, the most interesting exhibits were those outside of the domestic uses of gas. The number of gas engines was not numerous, but those shown were interesting. The Pennsylvania Iron Works Company, of Philadelphia, had an attractive exhibit of "Globe" gas and gasoline engines, and one of the gasoline engines of the marine type was shown in position in a handsome launch.

Fairbanks, Morse & Company, of Chicago, exhibited one of their horizontal gas engines, which attracted much attention because of its smooth running and its evident simplicity of construction. The American Motor Company, New York, showed a number of small motors for launches and horseless carriages; and the "New Era," built in Dayton, O., and "Mietz & Weiss" engines were among others shown.

The Safety Car Heating and Lighting Company of New York had an interesting exhibit of Pintsch gas and lamps. One of the lamps for passenger cars was a new design. It is of the inverted argand type, with a clear glass under the burner and a translucent dome through which the ceiling of the car is sufficiently illuminated to do away with all shadows there, while the absence of any obstructions below the reflector avoids the casting of shadows in other directions. The various lamps were arranged so that they could be fed with either Pintsch or city gas at the same pressure. The difference in the illuminating properties was strikingly illustrated. It must have been fully ten times as great with the Pintsch as with the city gas; in fact, there was all the difference between brilliant illumination and next to none. The company also exhibited a gas buoy lantern and a model of a gas buoy. These buoys have been purchased by our government to the number of about 100, and altogether there are about 500 in use in the world for lighting channels. The United States government has recently ordered 14 more of them.

The Continental Iron Works, of Brooklyn, N. Y., had an interesting exhibit. They build large quantities of gas plant machinery and apparatus, but their exhibit was not confined to this. The Morison protected fire door was shown, also a pressed steel furnace front, Morison suspended furnaces, self-sealing mouthpieces for retorts, quick closing gate valves, and several fine samples of welded steel flasks.

The Parker-Russell Mining & Manufacturing Company had an attractive exhibit of fire brick, gas retorts, locomotives, tiles, etc. The Joseph Dixon Crucible Company, Jersey City, exhibited graphite productions of various kinds.

The B. F. Sturtevant Company, of Boston, had an exhibit of blowers and exhausters. What attracted the writer most was a 4 inch by 3 inch double engine such as they make for driving their fans. It was running and was quieter and smoother in its movements than anything we ever saw in the engine line.

The Chapman Valve Company, Boston, had an exhibit of valves; the Wilkraham-Baker Blower Company, Philadelphia, and the P. H. & F. M. Roots Company, Connersville, Ind., each had exhibits of exhausters and blowers. The Armstrong Manufacturing Company, Bridgeport, Conn., had a striking exhibit of pipe fitters tools.

The Jarecki Manufacturing Company, Erie, Pa., had a pipe cutting machine in operation, the Heine Safety Boiler Company a model of their boiler, while the United Gas Improvement Company, of Philadelphia, and Bartlett, Hayward & Company, of Baltimore, each had extensive exhibits of gas plant apparatus.

EQUIPMENT AND MANUFACTURING NOTES.

The Milton Car Works, Milton, Pa., has received orders aggregating 50 tank cars.

The Wells & French Company, of Chicago, are building 100 cars after Santa Fe specifications.

The Commerce Despatch Line has placed an order with the United States Car Company for the repair of 200 cars.

The Drexel journal box and lid is to be used on 100 beef cars of Armor & Company being built by the Wells & French Company.

The Bethlehem Iron Company has received a contract for making the shafting and engine forgings for two big cruisers for the Japanese government.

The Schenectady Locomotive Works have just delivered two new engines to the Texas Midland. These engines are equipped with electric headlights.

The Westinghouse Electric & Manufacturing Company are reported to have secured a contract for 450 electric motors for the West End Electric Railway Company, of Boston.

The Charleston & Western Carolina has placed an order for 18 passenger and baggage cars, 250 box, 50 gondola, 75 flat and 8 caboose cars with the Ohio Falls Car Manufacturing Company.

The mails continue to bring to us calendars for 1897, and, while many of them are handsome, we have voted that none excel that of the Magnolia Metal Company, of 74 Cortlandt street, New York.

The Keystone Gas Engine Company, of New Brighton, Pa., have been incorparated, with a capital stock of $25,000. The directors are Milo A. Shoemaker, Charles W. Shoemaker and William B. Wallis.

The plant of the Ingersoll-Sargeant Drill Company at Easton, Pa., which has been working but five days a week for nearly a year, is now running full time in all departments. A number of foreign orders have been received.

The order of the Texas Midland for three locomotives, placed with the Schenectady Locomotive Works, included one passenger engine with cylinders 17 inches by 24 inches and two freight engines with cylinders 18 inches by 24 inches.

Safety hollow staybolt hose, manufactured by Falls Hollow Staybolt Company, are specified in boilers being built by the Richmond Locomotive and Machine Works for the International & Great Northern Railroad of Palestine, Tex.

The Flint & Pere Marquette Railroad has given a contract to the firm of F. W. Wheeler & Company, West Bay City, Mich., for the construction of another car ferry similar to the one already built by them and illustrated by us last month.

The largest order for locomotives given in some time was received last month by the Richmond Locomotive Works from the Charleston & Western Carolina Railway Company. It was for ten engines with an option for an additional number.

The Fairport Elevator Company have ordered from the Schoen Pressed Steel Company their diamond pressed steel bolsters, both for body and trucks, for the cars now building at the shops of the Missouri Car & Foundry Company at St. Louis, Mo.

The Steel Tired Wheel Company, of New York, has been incorporated at Trenton, N. J. The capital stock is $4,000,000, one-half of the amount being preferred. The incorporators are Hamilton J. Durand, of New York; John J. Tracy, of Jersey City, and Julius F. Workum, of New York.

It is reported that the Providence Steam Engine Company, which built the pair of large Greene engines for the Nantasket Beach power house of the New York, New Haven & Hartford Railroad, has the contract for two Greene cross-compound condensing engines for that company's new station at Berlin, Conn.

The Cleveland Tool & Supply Company, Cleveland, O., have been incorporated, with a capital stock of $20,000. The concern intend to manufacture and sell machinery, machine tools, factory supplies and other iron and steel goods. The incorporators are Frank C. White, F. C. Wittick, M. B. Johnson, Geo. Cook Ford and H. M. Johnson.

The Cleveland Ship Building Company, Cleveland, O., have decided to use Worthington compound independent air pumps and compound boiler feed pumps in the new steamer *Empire City* which they are now building for A. B. Wolvin, of Duluth, Minn. This boat is to be fitted with quadruple expansion engines and Babcock & Wilcox water tube boilers.

An electric lighting and power plant is now being installed in the works of the Schoenberger Steel Company, Pittsburgh, Pa. The plant consists of one 400 horse-power vertical cross-compound engine connected to a 225-kilowatt generator, and one 175 horse-power vertical compound engine connected to a 125-kilowatt generator. The engines were built by the Ball Engine Company, Erie, Pa.

The firm of Jas. P. Marsh & Company, 224 Washington street, Chicago, are doing what they can to disperse the darkness and uncertainty in those engine and boiler-rooms where the light of day seldom enters. They are making a steam gage that can be illuminated from the back, either by an electric light or a gas or oil-lamp. The back of the case consists of a suitable lense that diffuses the light over the entire dial, which is of such a character as to define the figures clearly. The gages are furnished in four sizes, with dials from 8½ to 16 inches in diameter.

Willis Shaw, 506 New York Life Building, Chicago, has just issued a 32-page booklet containing a large list of second-hand boilers, engines, air-compressors, pumps and contractors' appli-

ances. Mr. Shaw has recently furnished a large hoisting engine for the mines of the McLean County Coal Company at Bloomington. Ill., and will put in a pumping plant for the same company. Messrs. W. J. Marson & Company, at St. Johnsville, N. Y., who have one of the contracts for improving the Erie Canal, have placed an order with him for a steam shovel, for use in connection with this work.

Messrs. R. B. Campbell and F. S. Brown announce that they have formed a copartnership in the business of general contracting, succeeding to the business F. S. Brown & Company, of Chicago. It is their intention to handle railroad and public work of every description, making a specialty as heretofore of heavy masonry and substructure work, for which they are well equipped. It will be their aim and endeavor to continue the high standard of workmanship heretofore maintained by the firm of F. S. Brown & Company, and they guarantee satisfaction in every respect in any work with which they are entrusted.

The Barney & Smith Car Company, Dayton, O., is building three trains of vestibuled cars for the Kansas City, Pittsburgh & Gulf. Each train comprises one reclining chair car, one passenger coach and one baggage car, and all the cars are being equipped with Buhoup vestibules, Buhoup-Miller platforms and couplers, Westinghouse air-brakes, Pintsch gas and the Safety Car-Heating and Lighting Company's steam-heat apparatus. The company is also building for the same railroad 100 30-ton box-cars, which are to be equipped with Tower couplers, Westinghouse air-brakes, Chicago Car Roofing Company's "Chicago" roof and McGuire grain doors.

The E. P. Allis Company, Milwaukee, Wis., is completing two large compound vertical beam-blowing engines with high-pressure cylinders 40 inches in diameter, low pressure 78 inches in diameter, air cylinders each 76 inches in diameter, all by 60-inch stroke. The total shipping weight of each of these engines is over 600,000 pounds. They are for export, and will be shipped to the Krainische Industrie Gesellschaft of Triest, Austria. This concern is the largest iron manufacturing establishment in Austria. The E. P. Allis Company has furnished some 12 engines, duplicates of these, to the Carnegie Steel Company for their furnaces at Duquesne, Pa. The company is also negotiating for a large 1,200 barrel flour mill to be constructed in Braila, Roumania, and W. D. Gray, milling engineer, is now on his way over there for the purpose of closing the deal. The company has also received advices of the completion of a complete concentrating (gold and silver) plant, which was furnished for Jorge Basadre, Tacna, Chili, South America. This concentrating mill is situated 150 miles distant from a railroad and all the machinery had to be transported by mule back.

The Weber Gas and Gasoline Engine Company, of 485 S.W. Boulevard, Kansas City, Mo., are doing quite an extensive export business. Among recent foreign shipments of engines by this firm are: Two Weber gasoline hoisting engines going into the mining country of Kaslo, B. C.; one large size engine to operate a machine shop at Halifax, N. S.; one complete electric light plant, including engines and fixtures, to Merida, Yucatan; duplicate order for two engines for Piræus, Greece. In the United States the company are just finishing the installation of a large amount of irrigation machinery for the Consolidated Canal Company at Mesa, Ariz., and have just completed a large plant for Beyers Bros., of Sugden, Indian Territory, the last named having a capacity of 4,000 gallons of water per minute and the first named 7,500 gallons per minute. Their 1896 design engine is meeting with favor among operators of flour mills, mining machinery, electric light plants and other users of heavy and uniform power ranging from 18 to 50 horse-power. Another of their specialties is a 4 horse-power special agricultural engine, which is designed particularly to meet the wants of farmers, ranchmen, feeders and others requiring a small power for grinding, pumping for small irrigation plants and pumping water for stock supplies.—Iron Age.

The Phosphor-Bronze Smelting Company, Limited, Philadelphia, have issued an interesting little pamphlet on "Delta Metal." This remarkable metal, the pamphlet states, has established an enviable reputation in the military, naval and industrial circles of Great Britain and the Continent of Europe. It is an alloy of copper, combined with other metals in such a manner as to insure perfect regularity of composition and freedom from segregation; the resultant alloy showing great strength, toughness, rigidity and elastic resistance, combined with the desirable property of working hot. The metal is of fine color, does not draw verdigris, and resists the action of corrosion to a remarkable degree; it is particularly dense, and its high elastic limit fits it for the resistance of high pressures, either fluid or gaseous. When exposed to the temperature of high pressure steam its strength is less affected than that of other alloys. It works freely under the tool, does not clog the file, and when finished presents a fine surface susceptible of the highest finish. Delta metal is especially adapted for casting large pieces, such as propellers, gears, plungers, etc.; it can be forged or stamped with the greatest facility, and its qualities may be so regulated as to secure the strength of mild steel or the toughness of wrought iron. It is largely used for propellers and has given highest satisfaction. The company makes several alloys of the same general composition, some intended for castings, others for forged and stamped work, etc. The metal can be rolled or drawn either hot or cold. The pamphlet is embellished with several views or cast, forged and drawn work and a half-tone of a launch built entirely of Delta metal.

Our Directory

OF OFFICIAL CHANGES IN FEBRUARY.

We note the following changes of officers since our last issue. Information relative to such changes is solicicted.

Ann Arbor.—Mr. J. A. Miller has been appointed Purchasing Agent, headquarters at Toledo, O.

Atchison, Topeka & Santa Fe.—Master Mechanic T. Paxton has been transferred from Nickerson, Kan., to Fort Madison, Ia., to succeed Mr. J. Collinson, resigned; Mr. J. E. Gavitt has been appointed Master Mechanic at Nickerson. Mr. G. T. Neubert has been appointed Master Mechanic at Arkansas City, Kan., vice F. G. Tisdale, resigned.

Atlantic Coast Line.—Mr. R. E. Smith has been appointed Superintendent of Motive Power, with office at Wilmington, N. C.

Baltimore & Ohio.—Mr. R. W. Moore has been appointed Master Mechanic of the Pittsburgh Division, vice Mr. T. Trezise, resigned.

Chicago, Rock Island & Pacific.—Mr. J. W. Fitzgibbon has been appointed Assistant Superintendent of Motive Power to succeed Mr. Monkhouse, resigned.

Chicago & West Michigan.—Mr. E. V. R. Thayer has been elected Vice-President.

Georgia & Alabama.—Mr. J. E. Worswick, Master Mechanic at Americus, has resigned.

Grand Trunk.—Mr. Wm. Aird has been appointed Acting Master Mechanic at the Montreal shops.

Great Northwest Central.—Mr. H. F. Forest has been appointed Manager, with headquarters at Brandon, Man.

Greenwood, Anderson & Western.—Mr. C. W. Ward has been appointed Receiver.

Gulf, Colorado & Santa Fe.—Mr. James Collinson has been appointed Superintendent of Motive Power, vice Mr. G. A. Hancock, resigned.

Houston, East & West Texas.—Mr. M. G. Howe has resigned as General Manager, but will continue as Vice-President, and Mr. N. S. Meldrum succeeds him as General Manager.

Lake Superior & Ishpeming.—Mr. H. R. Harris has been appointed General Manager, with headquarters at Marquette, Mich.

Metropolitan Elevated.—Chief Engineer MacAllister has been appointed Receiver.

Oconee & Western.—Mr. R. H. England has been appointed General Manager, with office at Empire, Ga.

Pennsylvania.—President George B. Roberts died last month and the election to fill the vacancy necessitated several other changes so that the offices affected are now filled by the following gentlemen: President, Mr. Frank Thomson; First Vice-President, Mr. John P. Green; Second Vice-President, Mr. Chas. E. Pugh; Third Vice-President, Mr. S. M. Provost; First Assistant to the President, Mr. Samuel Rea; Assistants to the President, Messrs. Wm. A. Patton and E. T. Postlethwaite; Freight Traffic Manager, Mr. Wm. H. Joyce; General Manager, Mr. J. B. Hutchinson.

Pittsburgh & Lake Erie.—Mr. I. M. Schoomaker, formerly Vice-President, has been elected President, and Mr. J. P. Wilson has become Vice-President.

San Francisco & North Pacific.—Mr. A. W. Foster has been elected General Manager, vice Mr. H. C. Whiting, resigned. He continues as President. The office of Superintendent has been abolished. Mr. H. C. Whiting becomes General Superintendent.

Sharpsville.—Mr. G. M. McIlvane has been appointed Receiver.

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

APRIL, 1897.

CONTENTS.

The Largest of Ten-Wheeled Locomotives—Northern Pacific Railroad.

The Northern Pacific Railroad received last month from the Schenectady Locomotive Works two ten-wheeled compound freight engines which we believe can safely be pronounced the largest engines of that class ever built. The general design and details of the locomotives were worked out by Mr. E. M. Herr, Superintendent of Motive Power of the Northern Pacific Railroad, in consultation with the Schenectady Locomotive Works. Through the courtesy of these parties we publish herewith a full page engraving of one of the engines and the specifications.

The prominent characteristic of these engines may be expressed in two words: boiler power. Their great weight, 172,500 pounds, and several features of detail construction, are traceable to the effort to get an enormous boiler. That this has been attained is evident when we state that the heating rurface is nearly 2,900 square feet. All the details of the engines were designed with a view of giving the maximum of heating surface of boiler wit a given weight, to accomplish which, cast, forged and pressed steel were used extensively in place of cast and wrought iron.

The locomotives are of the two-cylinder compound type, having the Schenectady Locomotive Works design of intercepting valve which enables the engine to be operated either simple or compound at the will of the engineer. This intercepting valve is fully illustrated on page 127 in connection with the details of another large engine built for the same road. While operating compound on a 60-foot grade out of Schenectady, pushing freight trains, one of these 10-wheeled engines developed about 1,200 horse-power, and its operation in the test, both as compound and simple, was most satisfactory.

The boilers are of the radial stay extended wagon-top type, and in their general features are quite similar to the boilers for the Mastodon engines, illustrated on page 127. They are 70 inches in diameter at the front course and carry 200 pounds working steam pressure. The firebox is on top of the frames, the top rails of which are inclined back of the main drivers to give increased depth to the front end of the box.

The springs and equalizers are all underhung. The driving wheels centers are cast steel. The crank pins are hollow and the the parallel and main rods are all channelled and made as light as possible. The piston rod on the low-pressure side is extended through the front cylinder head. The rock shafts have hollow barrels.

The engine truck is of the swing motion type and the front and rear pair of drivers are flanged, the middle pair being plain.

The boiler front is of pressed steel, and pressed steel is we believe, used for several other parts of the engine. The cab is also of steel.

The specifications of the engine are as follows:

GENERAL DIMENSIONS.

Gage	4 feet 8½ inches
Fuel	Bituminous coal
Weight in working order	172,500 pounds
" on drivers	126,000 pounds
Wheel base, driving	14 feet 10 inches
" " rigid	14 feet 10 inches
" " total	25 feet 11 inches

CYLINDERS.

Diameter of cylinders	High pressure, 22 inches; low pressure, 34 inches
Stroke of piston	26 inches
Horizontal thickness of piston	4¾ inches and 5¾ inches
Diameter of piston rod	3¾ inches
Kind " " packing	Cast iron rings, sprung in
" " " rod packing	Jerome metallic
Size of steam ports	High pressure, 20 inches by 2⅛ inches; low pressure, 23 inches by 2⅛ inches
" exhaust ports	High pressure, 20 inches by 3 inches; low pressure, 23 inches by 3 inches
" bridges "	1⅜ inches

VALVES.

Kind of slide valves	Allen-American
Greatest travel of slide valves	6½ inches
Outside lap " "	High pressure, 1¼ in.; low pressure, 1⅛ in.
Inside clearance of slide valves	High pressure, ¼ in.; low pressure, ¼ in.
Lead of valves in full gear	0 inches
Kind of valve stem packing	Jerome metallic

WHEELS, ETC.

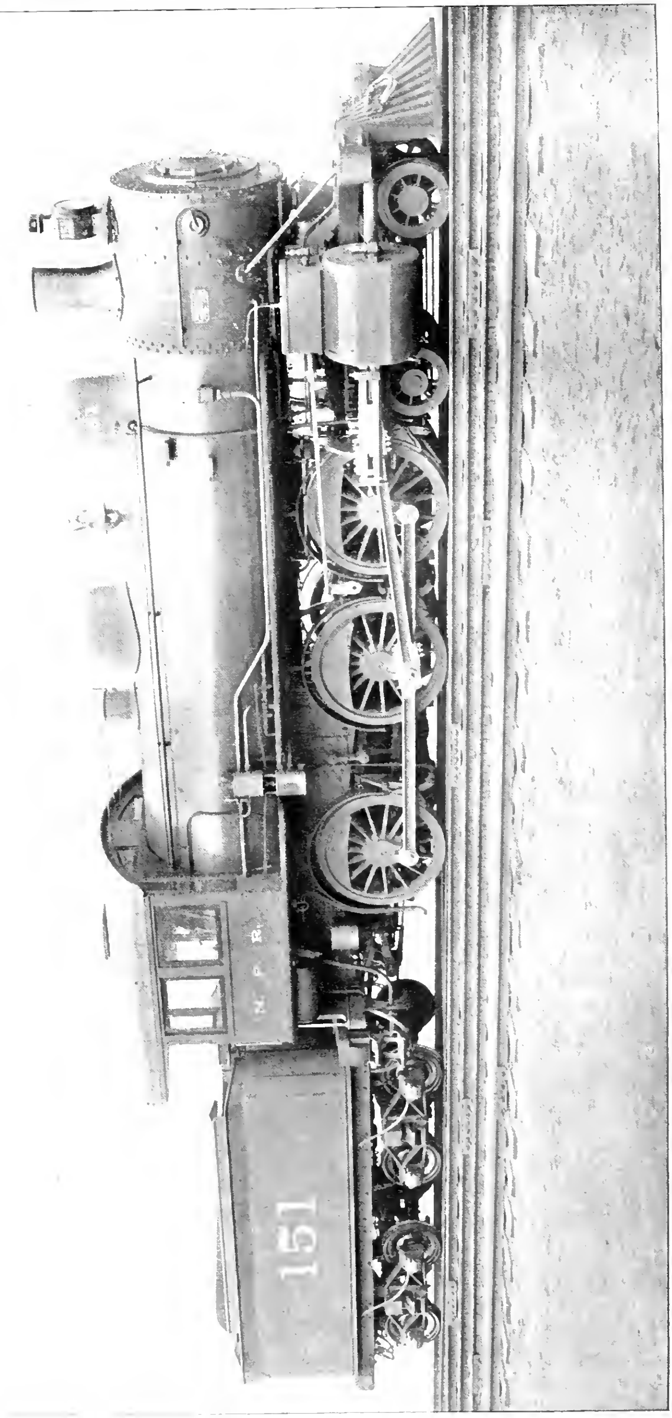
Diameter of driving wheels outside of tire	63 inches
Material of driving wheel centers	American cast steel
Tire held by	Shrinkage
Driving box material	Cast steel
Diameter and length of driving journals,	Main 9 inches, F. & B. 8½ inches diameter by 11 inches
Diameter and length of main crank pin jonrnals,	6½ inches diameter by 6 inches
Diameter and length of side rod crank pin journals,	Main 7 by 5¼ inches F. & B. 5½ by 4½ inches
Engine truck, kind	4 wheel swing bolster
Engine truck journals	6 inches diameter by 11 inches
Diameter of engine truck wheels	30 inches
Kind " " " "	Standard, steel tired spoke center

BOILER.

Style	Extended wagon top
Outside diameter of first ring	70 inches
Working pressure	200 pounds
Material of barrel and outside of firebox	Carbon steel
Thickness of plates in barrel and outside of firebox,	$\frac{11}{16}$ inch, ¾ inch, ⅝ inch, $\frac{9}{16}$ inch and ½ inch
Horizontal seams,	Butt joint, sextuple riveted, with welt strip inside and outside
Circumferential seams	Double riveted
Firebox, length	$120\frac{3}{16}$ inches
" width	41 inches
" depth	Front 84 inches, back 71½ inches
" " material	Car bon steel
" " plates, thickness, sides, $\frac{5}{16}$ inches, back, $\frac{5}{16}$ inches, crown, ⅜ inches, tube sheet, ½ inch	
" " water space, front, 4½ inches, sides, 3½ inches to 4 inches, back, 3½ inches to 4½ inches at crown	
" " crown staying	Radial stays 1⅛-inch diameter
" " stay bolts	Ulster special iron 1 inch diameter
Tubes, material	Charcoal iron No. 12 W. G.
" number of	378
" diam	2 inches
" length over tube sheets	13 feet 6 inches
Fire brick, supported on	Four water tubes
Heating surface, tubes	2,655,4 square feet
" " water tubes	32.1 square feet
" " firebox	203.0 square feet
" " total	2895.5 square feet
Grate surface	34.22 square feet
" style	Rocking
Ash pan, style	Sectional
Exhaust pipes	Single, high
" nozzles	5¼ inches, 5½ inches and 5¾ inches diameter
Smoke stack, inside diameter	18 inchos at top, 16 inches near bottom
" " top above rail	14 feet 10½ inches
Boiler supplied by	Two Sellers, improved Class M. No. 10½ injectors

TENDER.

Weight, empty	37,800 poundss
Wheels, number of	8, cast-iron plate wheels
" diam	33 inches
Journals, diam. and length	4½ inches diameter by 8 inches
Wheel base	15 feet 3 inches
Tender frame	10-inch steel chanoels
" trucks, 4-wheel, channel iron, center bearing F. & B. additional side bearings on back truck	
Water capacity	4,350 U. S. gallons
Coal "	9 (2,000 pounds) tons
Total wheel base of engine and tender	52 feet 9½ inches
" length " " " "	61 feet 4½ inches



COMPOUND TEN-WHEELED LOCOMOTIVE—NORTHERN PACIFIC RAILROAD.

E. M. HERR, *Superintendent of Motive Power.* *Built by the* SCHENECTADY LOCOMOTIVE WORKS.

The engine is provided with the American brake on all drivers, operated by air, the Le Chatelier water brake on cylinders, the Westinghouse automatic air-brake on tender and for train, Westinghouse air signal, three 3-inch Ashton safety valves, two of which are open pop and one with cam lever; the boiler is lagged with Sall Mountain asbestos, and the engine is also fitted with Dean's improved sand-feeding device, Kewanee reversible brake beams, McIntosh blow-off cocks and Star headlight with 16-inch round case.

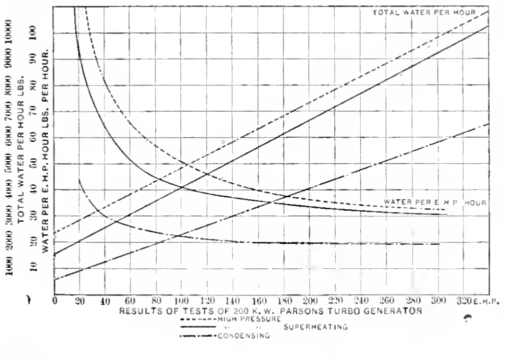
Test of a 200-Kilowatt Continuous-Current Parsons Turbo-Generator.

Last month we mentioned the remarkable performance of the "Turbina," a 100-foot boat fitted with Parson's steam turbines for furnishing the propelling power. Mr. W. D. Hunter has made public the following report of the test of one of Parson's turbo-generators, which is of interest in this connection:

On the 11th, 22d and 28th of January a series of tests were carried out on a 200-kilowatt continuous-current Parsons generator, for the purpose of determining the steam consumption under different conditions of service and various grades of output.

The generator was designed to work with a fair all round economy, whether exhausting into the atmosphere or a condenser, although, in general, the latter method is expected to be employed.

The difficulty of obtaining high economy imposed by such a set of conditions can only be partially met in ordinary practice by adding to the engine a costly automatic expansion gear, which cannot always be relied upon when required to act within a widely fluctuating range of load, or when called upon suddenly to work at full power, either high pressure or condensing. In the case of the Parsons turbo-generator, the provision for expansion is constant, and when designed to exhaust into a condenser only the terminal pressure would be about 1½ pounds to the square inch, with an initial boiler pressure of 140 pounds, the steam being thereby expanded about 100 times. The degree of economy obtained under these conditions is already well known, the last 150-kilowatt generator supplied to the Newcastle and District Electric Lighting Company requiring only 17.28 pounds of water per electrical horse-power per hour at full load.



RESULTS OF TESTS OF 200 K.W. PARSONS TURBO GENERATOR
-------HIGH PRESSURE
——— " " SUPERHEATING
—·—·—CONDENSING

When, however, the motor is required to give full power, working either high pressure or condensing (with a moderate consumption of steam), the problem of how to meet conflicting requirements presents many difficulties, and the fact that these difficulties have been successfully met in the design of the generator tested, without any addition being made to the cost or parts of the machine, is further testimony to the adaptability of the steam turbine for every condition of service. The particular machine tested had one of the parallel flow type of turbines coupled direct to a continuous-current dynamo, designed for a normal output of 200 kilowatts. Steam was admitted at one end of the cylinder, the admission being controlled by an exceedingly sensitive and effective electrical governor which reduced or prolonged the period of admission without in any way altering the initial pressure at the steam chest of the motor; there was, therefore, a complete absence of throttling, with the attendant disadvantages which would be felt when working on a fluctuating load. The action of the governor left nothing to be desired, the rise in voltage being only momentary when the whole load of nearly 280 electrical horse-power was thrown off. Between full load and no load the generator responded to whatever calls were made upon it without any hunting, this valuable property eminently fitting it for electric traction or haulage purposes.

During the trials measurements of electrical output, steam pressure, vacuum, etc., were taken each time the water from measuring tanks were used up, the intervals at full loads being about eight minutes. The measuring tanks from which the feed water was drawn were carefully calibrated, and the electrical output was taken by a Kelvin watt-meter, the readings of which were checked by ammeters and voltmeters. The figures obtained during the trials are shown in the table herewith.

TESTS OF 200-UNIT TURBO-DYNAMO.

Kilowatts.	Total water per hour.	Water per kilowatt.	Water per electrical horse power.	
	Lbs.	Lbs. per hour.	Lbs. per hour.	
219.2	9,466	43.20	32.22	Non-condensing.
98.7	5,848	59.23	44.18	"
54.5	4,330	79.50	59.30	"
0	2,092			
203.0	8,429	41.52	30 97	Non-condensing and superheating 30 deg. Fahr.
106.0	5,287	49.83	37.17	
0	1,402			
208.0	5,443	26.46	19.51	Condensing but no superheating. Vacuum at full load 25 in.
108.4	3,037	28.02	20 90	
0	531			

It will be noted that for the full-power trials the water used per electrical horse-power hour, when exhausting into the atmosphere, 32.22 pounds. Under similar conditions, but with the steam superheated 30 degrees Fahrenheit, the consumption was 30.97 pounds. With saturated steam and exhausting into a condenser (vacuum 25 inches) the consumption fell to 19.51 pounds per electrical horse-power hour.

The generator ran throughout the trials smoothly and without a hitch, the automatic lubricating arrangements acting perfectly.

Rail Specifications.*

At the Atlanta meeting of the institute, October, 1895, I had the honor of presenting a paper on "Specifications for Steel Rails of Heavy Sections Manufactured West of the Alleghanies." In it, reasoning from the experience of Western railroads with heavier sectioned steel rails, I called attention to the importance of the chemical composition of the steel, and urged the increase of the carbon percentage and the limiting of phosphorus to the lowest point reconcilable with commercial considerations, and also insisted on the value of added silicon.† My paper has been honored by the favorable consideration of a number of the engineers and other controlling officers of Western roads, and it resulted in over 186,000 gross tons of rails of sections heavier than 65 pounds per yard being manufactured since that time in accordance with my views. These rails are in the tracks of several large railway systems. In giving the above tonnage I refer only to the rails which came under my immediate supervision—that is, under the inspection of my firm. Over 69,000 tons were 80 pounds to the yard.

In some cases it was not commercially possible to obtain quite as low a percentage of phosphorus as desired, and hence the carbon was reduced proportionately, but as a whole the rails could be classed as high carbon ones. Of course it is too soon to form a positive opinion in relation to the wear of the rails, but practically all of them have been in service long enough to demonstrate their safety, and I believe in all cases the users of the rails unite in the opinion that so far they promise much better wearing results than previously obtained; and I know in several instances, based on such showing, still harder steel will be insisted upon in this year's deliveries.

I present this short article somewhat in the nature of a "report of progress." Moreover, in view of the recent somewhat surprising developments in the American rail trade, it is well not to lose sight of the necessity of not permitting low prices to be the only consideration. The first cost of rails is not all the story. This does not require discussion. If it is necessary to pay a little more for a good rail, true economy speaks in no uncertain voice in favor of so doing. Low prices are very attractive, but subsequent

* By Robt. W. Hunt, at the meeting of the American Institute of Mining Engineers.

† The chemical composition advocated was: Carbon, in 70-pound rails 0.43 to 0.54; in 75-pound rails, 0.45 to 0.53; in 80-pound rails, 0.48 to 0.56; 90-pound rails, 0.55 to 0.63; 100-pound rails, 0.62 to 0.70; phosphorus not to exceed 0.085; silicon not below 0.10.

economies in track maintenance, repairs to rolling stock, possibilities of high speed and comfort of passengers must not be ignored. The peculiarities of human nature must be remembered. They do not change very much. When articles are sold at a low price those in direct charge of the manufacture of them will, most likely, be expected to keey cost of production down to a corresponding degree. This may lead to temptation to cut some corners which had better have remained in full projection. At all events, it does not seem wise to ignore past experience in steel-rail metallurgy.

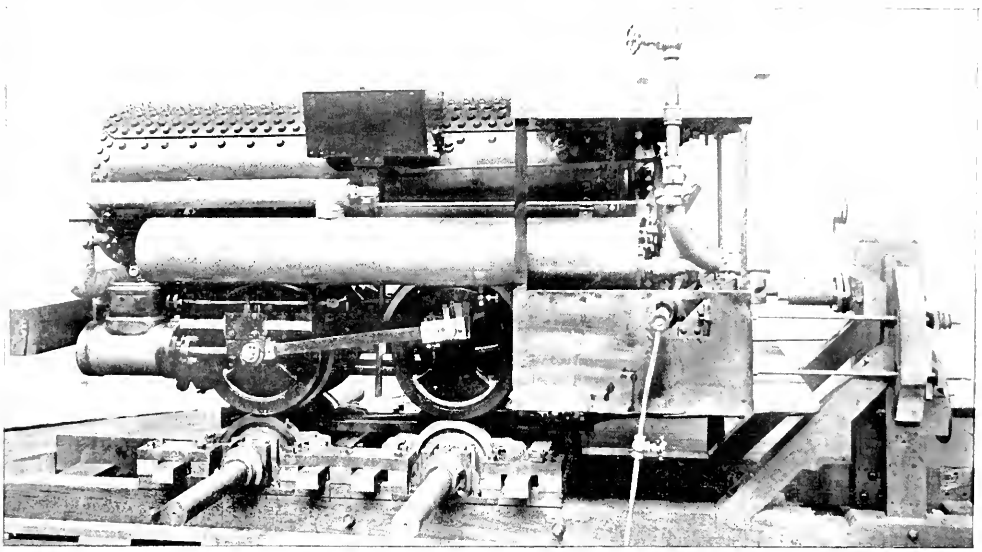
Tests of a Compressed Air Locomotive With and Without a Re-Heater.

The firm of H. K. Porter & Company, of Pittsburgh, Pa., has recently built a compressed air locomotive for the Anaconda Copper Mining Company, of Anaconda, Mont., on which some interesting tests were conducted before it left the shops of the builder. The engine has 5 inch by 10-inch cylinders and is for an 18-inch gage of track. It is shown in the accompanying illustration mounted on friction rollers for the test, at which time indicator cards were taken, and dynamometer and revolution counter records obtained.

At the time the tests were made the company had nearby a compressed air street car charged with air at 2,000 pounds' pressure, and connected to the little locomotive by ½-inch piping, so that the locomotive could be charged conveniently for the tests. There was also connected a large six-driver compressed air mine locomotive charged to 600 pounds. The friction rollers under the engine were arranged with brakes, to that by putting on the brake the resistance could be kept quite uniform, equivalant to the resistance of whatever the train might be in actual practice. For convenience the engine was run backward, the drawbar pushing instead of pulling. The dynamometer was a cylinder partly filled with oil, and proportioned so that 10 pounds' push on the piston registered one pound on the gage. Indicator cards were taken every minute, and during the hot test the temperature of the auxiliary reservoir was taken every minute. The revolutions and pressures were also taken every minute.

The dimensions of the locomotive are as follows; Cylinders, 5 inches by 10 inches; four driving wheels, 23 inches diameter; gage of track, 18 inches; height of locomotive, 4 feet 10 inches; width of locomotive, 4 feet 10 inches; length of locomotive, 10 feet 4 inches; pressure in main tank, 550 pounds; reduced pressure for auxiliary reservoir, 125 pounds; weight of locomotive, 10,000 pounds. The engine was built for the following work: Length of haul each way, 1,200 feet; load, 6 cars; weight of each car, 950 pounds; weight of load carried on each car, 2,500 pounds; track practically level; cars empty in one direction and loaded in the other. The engine was constructed to make two round trips, or 4,800 feet, with cold air, or three or four round trips with hot air.

The tests proved that with hot air the engine was able to make over five round trips under working conditions, with plenty of reserve air to allow for switching, etc.; or, if there had been grades as steep as two per cent. against the loaded cars, the engine was found to have capacity to make four round trips with one charge of air. During the test it was found to take 60 seconds to raise the pressure from 150 pounds to 550 pounds through ½-inch pipe. Under working conditions, with 1½-inch pipe and metallic couplings, the engine can be stopped, connected, charged, disconnected and started off again in 30 to 45 seconds. The locomotive tank is very heavily built, of ½-inch steel and ¾-inch heads, with a manhole in the front end made of steel castings. All the longitudinal seams are heavy butt joints, treble riveted, and the circumferential seams double riveted. The tank was tested for strength to about 50 per cent. above the working pressure. The pop valve for the main tank was set to blow off at 550 pounds, and the pop valve for the auxiliary tank to blow off at 300 pounds.



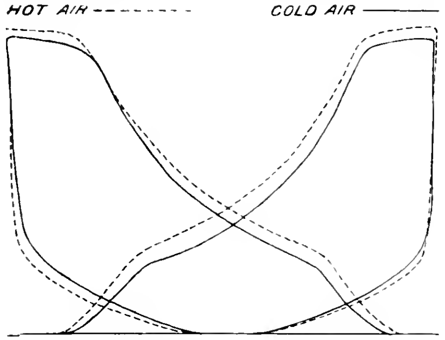
Tests of a Compressed Air Locomotive With and Without Re-Heater.—H. K. Porter & Co.

For the hot test steam was furnished from the shop steam pipes at low pressure. In practice steam at about 90 pounds' pressure would be used, and on this basis there would be a gain of 50 per cent. or more in the use of the re-heater over working the air cold.

It was found in taking the indicator cards that the indicator could be operated continuously for quite a while, allowing retracing the diagram exactly over the same lines, showing extremely even and perfect distribution of air and accuracy of the reducing valve, and proper working of the locomotive. The

pressure in the auxiliary reservoir was found to be maintained constant, with almost no fluctuations.

The indicator cards show a little too early exhaust, but before the locomotive was shipped the valve motion was modified to make the exhaust open later in the stroke, for the sake of greater economy in the use of air. All the cards show absolutely no back



Comparison of Diagrams Using Hot and Cold Air.

pressure, even when working the engine with maximum loads This amounts to a constant advantage over steam practice of say 10 pounds or 15 pounds.

The results of the tests are given in the accompanying table, and appear to show quite clearly the great economy in the use of air with the re-heater.

RESULTS OF TESTS OF COMPRESSED-AIR LOCOMOTIVE WITH AND WITHOUT RE-HEATER.

	Without Re-heater.	With Re-heater.
Temperature atmosphere	57 deg.	60 deg.
Barometer	29.39	29.38
Time of run	15 min. 20 sec.	24 min.
Distance run (feet)	5,761.14	10,312.26
Number revolutions	957	1,713
Revolutions per minute	62.55	71.37
Tank-initial pressure (gage)	525 in.	550 in.
" final " "	70 "	15 "
" drop in " "	455 "	505 "
Aux. res. initial pressure (gage)	130 "	140 "
" " final " "	45 "	30 "
" " drop in " "	85 "	110 "
M. E. P. by cards (mean of test)	H. E. 50.68 lbs. C. E. 47.63 lbs.	H. E. 42.86 lbs. C. E. 41.66 lbs.
Mean dyn. push (corrected)	534.3 in.	467.2 in.
Aux. res. initial temperatur, Fahr	....	320 deg.
" " final " "	....	192 "
" " drop in " "	....	128 "
B. T. U. from water	....	17,811.2
B. T. U. delivered per pound of air	....	148.91
Air delivered (in lbs.)	109.3553	119 6089
Work done at drawbar per cubic foot free air	2,140 ft. lbs.	3,100 ft. lbs.
Total work at drawbar	3,078,177.1 ft. lbs.	4,817,887.9 ft. lbs.
Work done at drawbar per pound of air delivered	28,148.4 ft. lbs.	40,283.2 ft. lbs.
Work including engine friction per cubic foot free air	2,450 ft. lbs.	3,600 ft. lbs.
Per cent. gain, hot air over cold air	....	47.1

We give herewith two indicator cards superimposed, one taken with the air cold and the other with it heated. The dotted card is for heated air. The data for these cards is as follows:

	Cold air.	Hot air.
Mean effective pressure, head end	46.66	52.45
" " " crank "	41.44	48.66
Cut off, head end	.30	.30
" crank "	.29	.29
Revolutions	58	72
Drawbar pull	479	437
Work done per minute (foot pounds)	167,248	189,413
Air used " " (pounds)	6,627	5,238
Work done per pound of air (foot pounds)	25,230	36,160
Per cent. gain over cold air	....	40

The company claims that actual results obtained in practice with other compressed air locomotives built by H. K. Porter & Company, demonstrate that power can be conveyed and used more economically by compressed air than by electricity. Actual figures show that, running the locomotive and the plant reasonably close to its full capacity, coal can be hauled at less than $\frac{3}{4}$ cents per ton per mile, including returning the empty trains, and also including a very large allowance for interest, depreciation and various contingencies. The cost of hauling coal, not reckoning interest, depreciation and contingencies, is less than $\frac{1}{2}$ cent per ton mile.

The Largest Locomotive Jib Crane.

What is stated to be the largest locomotive jib crane ever built has been erected at the United States Navy Yard, Mare Island, California, by the American Hoist and Derrick Company, of St. Paul, Minn. The crane has a capacity of 45 net tons raised at the rate of 14 feet per minute. The longest reach of the boom is 75 feet from the center of the track, and the reach of the boom, when the point is elevated, is 60 feet. The time required to raise the boom point from 75 feet to 60 feet is 11 minutes, and the time of slewing the boom a complete revolution is two minutes. The gauge of the track is 20 feet. The speed of travel of the crane along the track is 60 feet per minute.

The crane is operated by a 60-horse-power engine of the double cylinder type, with the cranks set at right angles. The boiler is of the vertical type, 4 feet in diameter by 10 feet in height. The crane deck rests upon 50 steel rollers. The large rotating rack is 23 feet in diameter. All the gearing is of cut cast steel and the large gear on the drum is 7 feet in diameter and weighs 3,200 pounds. The hoisting block weighs 1,500 pounds, the swivel working on hardened steel rollers. The wire rope is of plow steel $1\frac{5}{16}$ inch in diameter.

The platform of the crane is mounted upon four beams, arranged one at each corner, which are supported each upon a pair of two-wheeled trucks, the connections between trucks and beam and beam and platform being pivotal to permit freedom of adjustment of the truck-wheels to the curvatures of the track.

Between the front and rear trucks, on each side, is arranged a driving or traction wheel, the two being connected by a cross beam or truck, and each being double flanged to prevent derailment.—Iron Age.

Hardening Steel.

Metallurgists now think they know why a piece of red-hot tool steel becomes flint hard when suddenly quenched in water. For years they have been satisfied with the explanation that the shock drove the molecules of the steel into closer contact, hence the hardness, but this theory was completely destroyed by the fact that the volume of the hardened steel was greater than that of the unhardened material. After five years' search the metallurgical department of the Sheffield Technical School had solved substantially this difficult problem. It had been necessary to employ very intricate physical apparatus, the object of which was to measure accurately what seemed a paradox, namely, how much hotter a piece of steel became on cooling, and how much cooler it became on heating. These phenomena were due to the formation or dissociation of compounds within the steel itself. The result of the researches showed, almost beyond doubt, that the almost diamond hardness of quenched steel was due to the presence of a remarkable sub-carbide of iron, and that the action of tempering was due to the fact that far below red heat, this compound decomposed and diluted the mass with soft iron. The permanent magnetism of steel depended on the amount present of this compound.--Engineering Mechanics.

The Maintenance of Iron and Wooden Underframes of Freight Cars in France.

BY M. L. TOLMAR,

GRADUATE OF L'ECOLE POLYTECHNIQUE.

CHIEF OF THE SHOPS OF THE EASTERN RAILROAD OF FRANCE, AT MOHON (ARDENNES).

(*Continued from page 83.*)

COST OF MAINTAINING THE VARIOUS TYPES OF WAGONS.

Outside of the inspection of the cars and the small repairs that follow (tightening a bolt, replacing a screw, tightening a chain, etc.), we can divide the maintenance into two parts:

1st. The light or running repairs.

2d. The heavy repairs and alterations.

The work of light repairs requires only workmen of very ordi-

nary ability, but alert and well directed, and who understand only the assembling and taking apart of parts kept in stock. The car is usually out of service but one day. From this body of workmen the inspectors are selected, whose duties consist in inspecting the rolling stock, the repairs in case of damage, lubricating the journals, etc.

We have estimated the cost of repairs thus made to the underframes of nearly 15,000 cars in various shops in the Eastern Railroad of France and for each passage. The results are found in the following table, in which are included the general expenses of superintendence and the office, the indemnities for injury, sickness and absence on leave, heating and lighting, the shunting of cars with horses on repair tracks, the sinking fund for the buildings and rolling stock, and the interest on the capital tied up in the materials carried in the storehouse. Conforming to the general usage in France, Belgium and Germany, these general expenses are valuated at 100 per cent. of the cost of labor.

The time which elapses between two successive entrances of cars into the shops for heavy repairs may be fixed approximately as follows:

1st. Every 15 years for the cars with underframes of wood or of iron and wood mixed.

2d. Every 20 years for the cars with iron frames.

TOTAL REPAIRS OF THE CARS.

The cars wholly of wood that are about 30 years old are at the end of their career. They are, then, according to circumstances, either demolished or reconstructed, using the same ironwork. The reconstruction costs about 30 per cent. of the cost of a new car, and the same ironwork might possibly undergo this reconstruction twice, that is to say, the ironwork would last 50 to 60 years if repaired and kept in good condition, the cost of which is included in the expenditure of the 30 per cent. above mentioned. But it must be observed that so far as the frame itself is concerned, the cost of reconstruction is practically equal to the cost of a new frame less the ironwork valued at about 25 francs ($5), and the economy of reconstruction depends chiefly upon the utilization of the box, the draw-gear and buffers and the running gear.

AVERAGE COST IN FRANCS OF ONE LIGHT REPAIR TO CARS OF VARIOUS TYPES.

Kind of frames.	Class of Cars.											
	Flat cars.				Uncovered cars.				Covered cars.			
	Material.	Labor.	General expenses (100 per cent.).	Average total expense per each small repair.	Material.	Labor.	General expenses (100 per cent.).	Average total expense per each small repair.	Material.	Labor.	General expenses (100 per cent.).	Average total expense per each small repair.
Wood	6.13	2.36	2.36	10.85	3.70	1.51	1.51	6.72	3.46	2.23	2.23	7.92
Mixed	2.30	1.54	1.54	5.38	2.65	1.05	1.05	4.75	3.34	1.64	1.64	6.62
Iron	0.95	0.70	0.70	2.35	0.80	0.62	0.62	2.01	1.31	0.73	0.73	2.77

On the other hand, a very complete statistical statement demonstrates that the intervals of time between repairs differ greatly with the various types of cars. The annual expenses for repairs are as follows:

ANNUAL COST IN FRANCS OF REPAIRS TO CARS.

Kind of frame.	Class of cars.					
	Flat cars.		Uncovered cars.		Covered cars.	
	Average time elapsing between two light repairs.	Annual cost per car.	Average time elapsing between two light repairs.	Annual cost per car.	Average time elapsing between two light repairs.	Annual cost per car.
Wood	6 mos.	21.12	3 mos.	26.04	5 mos.	17.04
Mixed	8 mos.	7.95	3 mos.	18.48	6 mos.	12.44
Iron	11 mos.	2.16	4 mos.	5.31	11 mos.	2.17

Although the average expense of the heavy repairs depends upon many circumstances—method of construction, kind of material, age of car, damages that it has undergone, etc.—the same work carried out for the heavy repairs has given the following results, which appear acceptable since they cover a large number of cars:

To these expenses it is proper to add the depreciation the car undergoes in service, notwithstanding it has been well cared for. Practically and for the determination of indemnities in case a car is destroyed on a neighboring line, the French companies fix the annual depreciation by the formula $\frac{4\ P}{600}$ where P is the first cost of a new car, deduction being made for the wheels and axles.

GRAPHIC REPRESENTATION OF THE RESULTS OF THIS DISCUSSION.

In order to bring these data together and to make the results more clear we will use a graphic method consisting of rectangular co-ordinates, in which expenses will be represented by ordinates and the time since the date on which the car was constructed by obscissas. In this diagram the line A is for the wooden cars, B is for the cars with mixed frames and C is for the cars with iron frames, corresponding respectively to the prices of these different frames which have been approximately averaged at

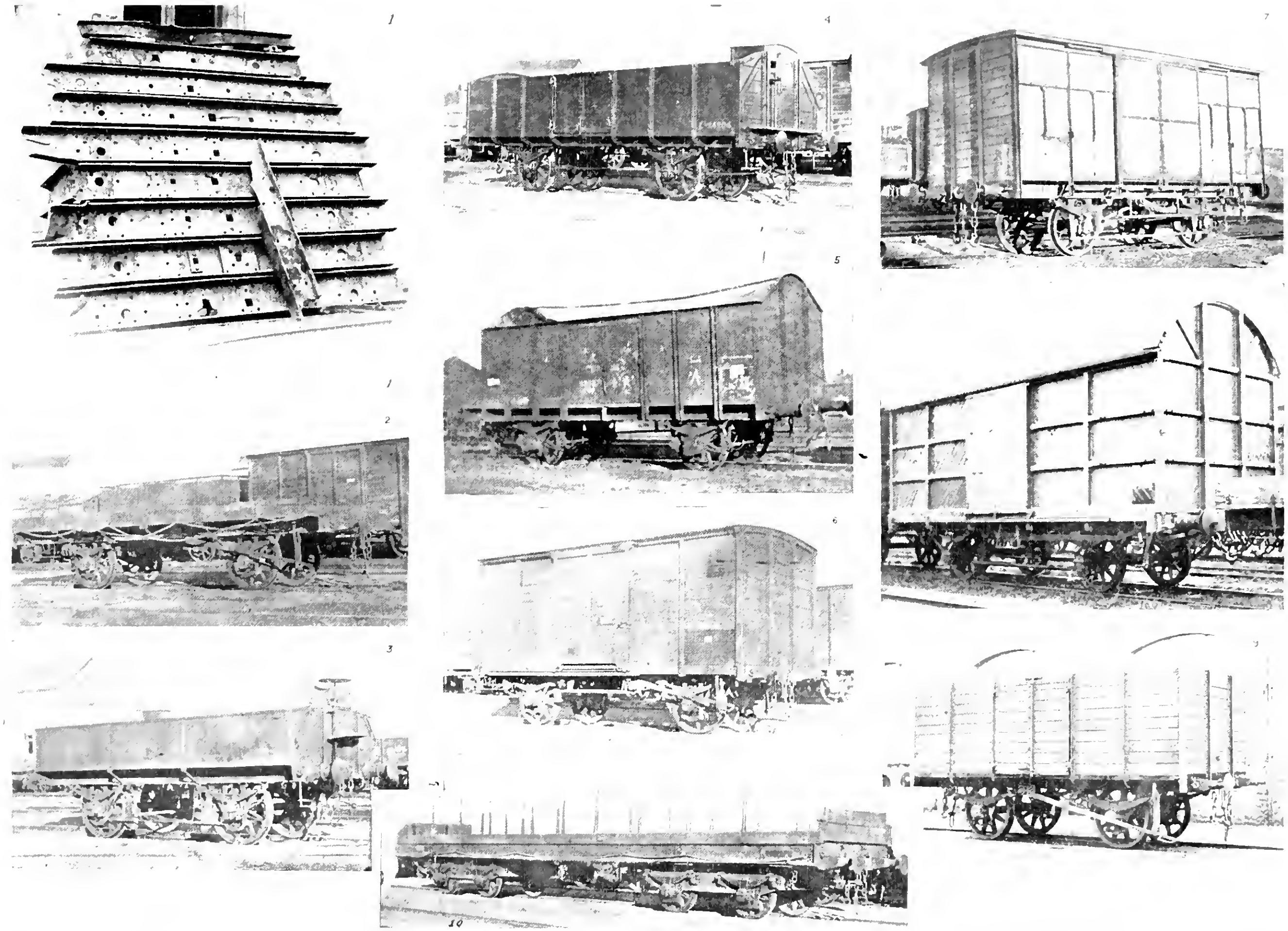
180 francs ($36) for wooden framed from 4 to 5 meters (13.1 to 16.3 feet) long.

260 francs ($52) for mixed frames from 5 to 6 meters (16.3 to 19.7 feet) long.

AVERAGE COST IN FRANCS OF ONE HEAVY REPAIR TO VARIOUS CLASSES OF CARS.

Kind of Frames.	Class of cars.											
	Flat Cars.				Uncovered Cars.				Covered Cars.			
	Material.	Labor.	General expenses.	Average total cost of one heavy repair	Material.	Labor.	General expenses.	Average total cost of one heavy repair.	Material.	Labor.	General expenses.	Average total cost of one heavy repair.
Wood	91.50	35.75	35.75	163.00	61.77	29.23	29.23	123.23	14.98	11.29	11.29	37.56
Mixed	31.21	22.50	22.50	76.21	28.22	15.36	15.36	58.94	21.86	15.15	15.15	52.16*
Iron	7.76	10.54	10.54	28.84	8.21	10.10	10.10	28.41	9.46	7.80	7.80	25.06

* These figures appear abnormal, which must be attributed to some special circumstances, and must be accepted with reserve.



1.—View of iron sections deformed by collisions. 2.—10-ton flat car on Eastern Railroad, iron frames. 3.—10-ton car with iron body and frames, on annexed line of Eastern Railroad. 4.—15 ton car with iron frames and wooden box with doors on Eastern Railroad. 5.—10-ton car with iron frames and box and with doors, Belgian State Railway. 6.—10-ton covered cars with iron frames and wooden box, Eastern Railroad. 10.—30-ton flat car with iron frames and trucks, Eastern Railroad. 7.—7-ton covered car with iron upper and under frames, Paris, Lyons, Meditteranean Railroad. 8.—10-ton covered car with iron upper and under frames, Belgian State Railways. 9.—20-ton car with iron upper and under frames, Eastern Railroad.

VIEWS OF FRENCH AND BELGIAN CARS WITH IRON FRAMES.

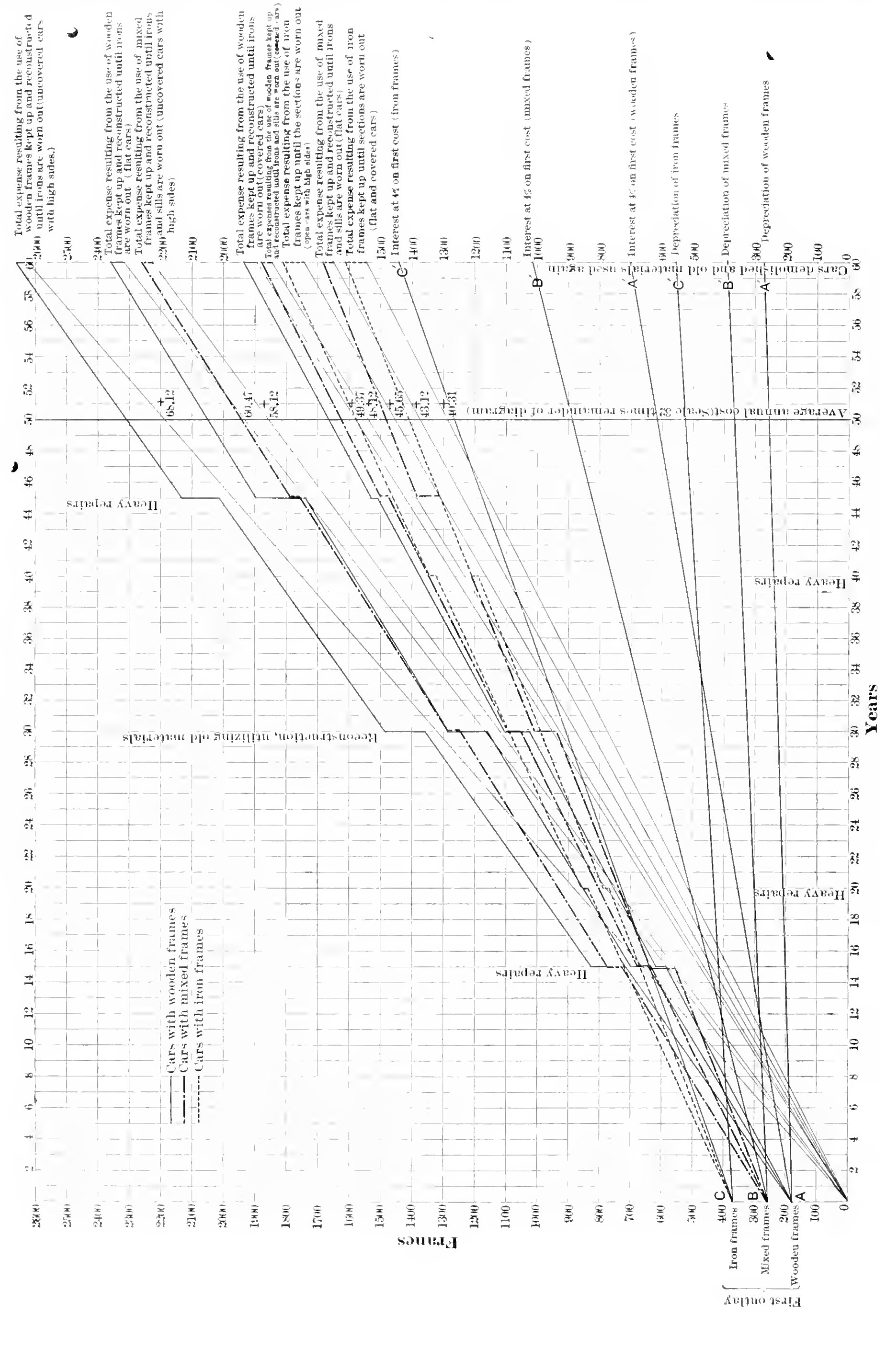


DIAGRAM SHOWING COST OF MAINTENANCE OF FRENCH FREIGHT CARS WITH WOODEN, MIXED AND IRON UNDERFRAMES.

370 francs ($74) for iron frames from 7 to 8 meters (23 to 26.3 feet) long.

Into the computation we bring the following items :

1st. The amount of normal depreciation due to service.

2d. Interest at 4 per cent. on the cost of the frames.

This gives the lines $A\ A^1$, $B\ B^1$, $C\ C^1$, the ordinates of which are next increased by

1st. The cost of light repairs proportioned to the time.

2d. The heavy repairs made at the end of 15 years on the wooden and mixed frames.

3d. The cost of construction after 30 years of service, using the old ironwork, and diminished by the deduction at each reconstruction and at the final demolition of the value of the scrap and old material, estimated at one-sixth the price of a new frame. This gives us the full lines for the wooden frames, the broken lines for the mixed frames and the dotted lines for the iron frames.

We cannot attach to the graphic representation a significance not derived from the data on which it is based, but the facts are so strikingly illustrated that one cannot but accept the following deductions and conclusions:

CONCLUSIONS.

1st. In an enterprise or undertaking of a transitory nature one can be content with wooden cars, which for 15 years will not involve expenses greater than those of mixed or iron frames.

2d. An enterprise of long duration should seek permanence in its constructions, at the risk of diminishing a little the benefits accruing during the earlier years, and to this end must use metallic frames.

3d. Concerning cars generally but little used, our covered cars for example, the mixed frames can often be quite judiciously employed, uniting the advantages of both wooden and iron frames.

We admit that a serious objection can be made because of this last remark, namely, that we have after all occupied ourselves chiefly with the frames and not with the whole of the car. To that objection we will answer that that which is true of the frames of European cars, which are of small expense compared with the total price of the car, will certainly be true for a car with bogies or trucks in which the cost of the frame is a greater proportion of the total cost of the car.

All the data which serve as a basis for the preceding calculations are, on the other hand, capable of being modified under some circumstances so as to make the metal frames even more economical than appears in these calculations. On European roads the need of reducing the expense of maintenance is not always the dominant motive which guides the engineer in charge of the designs. Several other considerations, such as those resulting from obligations to the military service, to the customs, etc., enter into account. No doubt if freed from such considerations and by taking advantage of recent progress, we can obtain a most excellent solution of the problem.

As a closing word, we might say that the experience acquired in Europe with cars carried on bogies is limited to a few specimens. We give herewith a view of one of the cars constructed by the Eastern Railroad of France, which may be considered a good type and one which requires but small expense for maintenance.

Railway Engineering at Purdue University.

We have received from Purdue University a circular with the above title, which we believe to be so important to railway interests, and so much in line with what we believe is needed for the technical education of those who propose to enter the railway field, that we print it in full :

American railways are entering upon a period of development the conditions of which are more exacting than any they have hitherto experienced. With an enormous expansion of the volume of traffic, with a demand for increased speed and the consequent necessity for attention to the question of safety, and with an ever-increasing competition, there is need for the highest possible efficiency in every department of railway service, and, consequently, a demand for men who are thoroughly trained for the service they are expected to render. In the future many of these men will come from the technical schools, and for this reason it seems desirable that these schools arrange courses which shall have special reference to the requirements of such service.

Purdue University has for several years offered work covering a considerable variety of railway subjects; but recently, to provide more perfectly for the railway interests, the plan of existing work has been revised and extended until there are now offered, for the year beginning Sept. 15, 1897, eleven systematic courses and a series of special lectures. Courses, numbered one to four inclusive, are open to regular students in mechanical engineering; five to eight inclusive, to regular students in civil engineering, and seven to eleven inclusive, to all engineering students. All of these courses are open to graduate students. They are as follows:

1. *Railway Equipment.*—Recitations and lectures on locomotive construction, principles of locomotive design, a comparative study of locomotive details, car design, train brakes and signals, and car lighting, heating and ventilating.

2. *Locomotive Performance.*—An analytical study of the performance of simple and compound locomotives as shown by the results of road and shop tests, and a study of conditions affecting locomotive efficiency.

3. *Laboratory Work.*—(*a*) Locomotive testing involving practice in taking all observations incident to complete efficiency tests of locomotive Schenectady, and in working up observed data obtained from such tests; also tests of Purdue's Baldwin compound locomotive engine.

(*b*) Locomotive tests in series arranged for the purpose of showing the effect upon the efficiency of the machine, of changes in the proportion of parts and of changes in adjustment or of conditions.

(*c*) Tests to determine the performance of air pumps, of several elements of the Westinghouse brake system, and of systems of car lighting.

4. *Locomotive Design.*—Drawing-room practice in the design of locomotive details and in calculating their strength and deflection.

5. *Railway Surveying.*—Including reconnaissance, field location, levels, topography, construction of map, profile and grade lines.

6. *Railway Construction.*—Recitations and lectures in cross-sectioning, classification and computation of quantities, estimates, track-laying including yard construction, trestling, bridging, methods of pile-driving, pile foundation, supporting power of piles, railway culverts, bridge abutments and piers.

7. *Economics of Railway Location.*—Recitations and lectures on sources of income, operating expenses, effect of details of alignment, of gradients and curvature, and economy of construction.

8. *Laboratory Work.*—Tests to determine the strength and other physical properties of various elements common to railway construction, such as links, pins, turn-buckles, axles, channels, rails and rail joints; also tests of standard specimens of different constructive materials.

9. *Railway Chemistry.*—Lectures and laboratory practice concerning the general applications of chemistry to railway interests; the chemistry of iron and steel, fuels, water, lubricants and paints, and concerning chemical requirements in specifications.

10. *Railway Economics.*—Lectures on the industrial importance of the railway, general principles underlying railway management, the organization of railway departments, the business administration of railways, railway rates and the railway and public opinion.

11. *Railway Sanitation.*—A study of the sanitary conditions of railway cars and stations; preparation for emergencies, health of employees and educational and financial aspects of sanitation.

In addition to the preceding courses, which will be administered by members of the University Faculty, a series of lectures will be given by men high in their profession and representing different departments of railway organization, upon subjects relating to their departments. These will be open to all engineering students. The following is a partial list arranged alphabetically of those who will take part in this course during the school year of 1897 and 1898:

Jacob N. Barr, Superintendent Motive Power, C., M. & St. P. Railway Company, Milwaukee. (Subject to be announced.)

J. T. Brooks, Second Vice-President Penn. Lines west of Pittsburgh. "Problems in the Management of a Railway System."

Frederic A. Delano, Superintendent Freight Terminals, C., B. & Q. Railway Company, Chicago. "Signaling."

Frank G. Darlington, Superintendent P., C., C. & St. L. Railway Company, Indianapolis. "The Management of Men."

Charles B. Dudley, Chemist, Pennsylvania Railway Company, Altoona. "The Application of Chemistry to the Railroad."

Addison C. Harris, Attorney-at Law, Indianapolis. "Railway Law."

Melville E. Ingalls, President of the Big Four System, Cincinnati. "Railways; Their Past, Present and Future."

George K. Lowell, General Superiniendent L., N. A. & C. Railway Company, Chicago. "Practical Points in the Operation of a Railway."

John W. Noble, ex-Secretary of Interior, St. Louis, Mo. "The Mutual Obligations of Railroad Corporations and the People."

Robert Quayle, Superintendent Motive Power and Machinery, C. & N. W. Railway Company, Chicago. "Business Problems of the Motive Power Department."

Godfrey W. Rhodes, Superintendent Motive Power, C., B. & Q. Railway Company, Aurora, Ill. (Subject to be announced).

Angus Sinclair, Editor Locomotive Engineering, New York City. "Reminiscences of a Locomotive Engineer."

Arthur M. Waitt, General Master Car Builder, L. S. & M. S. Railway Company, Cleveland. "Car Designing and Construction."

A full description of the work required of students in civil and mechanical engineering will be found in the annual catalogue of the university.

For further information concerning this special railway work application may be make to Prof. W. F. M. Goss, or to

JAMES HENRY SMART,
President Purdue University,
LaFayette, Ind.

March 1, 1897.

High Carbon Steels for Forgings.*

BY A. L. COLBY, SOUTH BETHLEHEM, PA.

It is only in recent years that high carbon steel has been found available for this class of work. Friedrich Krupp, of Essen, was the leader in substituting his soft crucible steel for wrought iron in heavy forgings. After 1870 soft open-hearth steel became a more frequent substitute with such success that, compared with wrought iron, the soft steel forgings made by such firms as Vickers Sons & Company, of Sheffield, and Sir Joseph Whitworth & Company, of Manchester, England, soon attained a high reputation for their quality.

Shafting.—It was, therefore, natural that our government officials, when first issuing specifications for the heavy engine and shafting forgings required for the rebuilding of our navy, followed in the line of the English practice and called for a steel having a tensile strength in the specimen cut from the forgings of 28 to 30 tons (62,720 to 67,200 pounds) per square inch, and a minimum elongation of from 22 to 28 per cent., according to the dimensions of the specimen and the severity of the specifications. To-day, however, the Bethlehem Iron Company are called upon by the government to furnish a steel for thrust line and propeller shafts which will show a tensile strength of 80,000 pounds (36 tons), an elastic limit of 50,000 pounds (22 tons), and an average elongation of 25 per cent. in four diameters, and the International Navigation Company also specify for shafting a steel of an elastic limit of 50,000 pounds and 25 per cent. elongation in four diameters. These requirements are met by using a steel of 30 carbon and 3¼ per cent. nickel.

Crank Pins.—The character of steel now used by some railroads for crank pins furnishes a marked illustration of the practicability of using high carbon steels. When steel was first used in such pins in place of wrought iron a soft low carbon steel was generally employed, and the failures due to "fatigue" of the metal were almost as numerous as when wrought iron was used. The broken pins showed what has been called "a fracture in detail," a gradual parting of the steel extending inward all around the piece, undoubtedly produced by the working strains repeatedly approaching the low elastic limit of the soft steel. On substituting a steel with an elastic limit of 45,000 pounds failures were greatly diminished, and that without changing the diameter or shape of the pin. We make crank pins of fluid compressed open-hearth steel of about the following composition, which have given excellent satisfaction in locomotive service:

Carbon	0.40-0.45
Manganese	0.60-0.70
Phosphorus and sulphur	0.030
Silicon	0.10-0.18

This same grade of steel is now being used by such firms as the Southwark Foundry & Machine Company, Philadelphia; the Corliss Steam Engine Company, Providence; the Atlantic Works, East Boston; Fraser & Chalmers, Chicago, for piston and connecting rods and crank pins, under specifications of 40,000 to 45,000 pounds elastic limit and 18 to 20 per cent. elongation.

Hammer Rods.—The use of soft steel for piston rods for steam hammers, especially for those of large sizes, is a good example of the error into which engineers have been led by the exercise of a caution which was not based on a thorougn knowledge of the facts. The argument that the soft steel was safer, because less liable to rupture if subjected by accident to a sudden transverse blow, has caused engineers to select so soft a steel that it was unable to resist for any length of time the strains put on it in regular service, strains which so constantly closely approach the low elastic limit of soft steel that the metal breaks down from gradual fatigue, causing distortion, which is soon followed by fracture. Some years ago we persuaded a customer to allow us to use a 45 carbon steel for a hammer rod. This rod was 19 feet long, the lower half 18 inches in diameter, and the upper half 10 inches. The machined weight was 6 tons. We used a fluid compressed ingot containing carbon, 0.45; manganese, 0.48; phosphorus, 0.025; sulphur, 0.030; silicon, 0.144. This rod stood very service for three years and seven months, which was so much longer a period than the soft steel hammer rods previously used had lasted that our customer, in ordering one to replace it, asked us to make the carbon still higher. We have, therefore, furnished a rod which is now in use, selecting a steel analyzing carbon, 0.55; manganese, 0.74; phosphorus, 0.024; sulphur, 0.030; silicon, 0.181, and obtained the following results on a 2-inch test bar, machined cold, from a prolongation of the forging after finished annealing: Tensile strength, 103,390; elastic limit, 53,980; elongation, 17.10; contraction, 28.76. A similar example of the success attending the substitution of a higher carbon steel is found in the record of a ram for a 20-ton hammer, where excellent service has been obtained from a 0.43 carbon steel. The test-piece from the finished annealed forging gave the following results: Tensile strength, 87,440; elastic limit, 48,060; elongation, 15.00; contraction, 63.84. In the cases just cited the forgings were simply annealed after forging. The following record shows the advantages gained by oil tempering high carbon forgings: We furnished a piston rod for a 20-ton hammer made of 0.45 carbon steel, which has now been in use five years nine months. The rod is 19 feet 4 inches long and 12 inches diameter, and has a 4-inch axial hole bored after forging. After forging and boring it was annealed, oil tempered and re-annealed, and a test bar taken from a prolongation of the forging after final treatment gave the following results: Tensile strength, 88,970; elastic limit, 50,100; elongation, 22.85 per cent.; contraction, 47.07. The analysis of this steel is: Carbon, 0.46; manganese, 0.63; phosphorus, 0.021; sulphur, 0.026; silicon, 0.155.

Selection of Steel for Forgings.—No fixed rules can be framed in the selection of steel for forgings, as the size and shape of the piece and the qualities most desirable for the work it is intended to do make each case almost a separate study. In general, however, it can be stated that our experience shows us that where high duty is demanded from a forging, mild steel of a tensile strength of 60,000 pounds (28 tons) is not the best material to use, owing to its low elastic limit. In substituting hard or higher carbon steel we recommend that the forging should be oil tempered whenever practicable, as this treatment effects a decided improvement in the physical qualities, increasing both elastic limit and toughness. The less the sectional thickness of the piece the more its qualities are improved by tempering. In order to successfully temper a large forging, especially if cylindrical in shape, it is necessary to provide it with an axial hole throughout its length. In cases where oil tempering is not prac-

* Read before the Engineers' Club of Philadelphia.

ticable and special requirements are demanded, they can be obtained by using a somewhat softer and tougher steel and the introduction of from 3 to 4 per cent. nickel. This nickel increases the ratio between the elastic limit and tensile strength, and also adds to the ductility of the steel. The following statement shows the average physical qualities that can be obtained in forgings made of the several grades of steel mentioned, the test specimens being ½ inch diameter and 2 inches long between marks and cut from full-sized prolongations of the forgings after treatment, the elastic limit being determined, not by the drop of the beam, but by an electric micrometer :

	Mild steel, annealed.	Medium hard steel, annealed.	Medium hard steel, oil tempered. (Axial hole where practicable.)	Medium hard nickel steel, annealed.	Medium hard nickel steel, oil tempered (Axial hole where practicable.)
Tensile strength	63,000	80,000	90,000	85,000	93,000
Elastic limit	30,000	37,500	48,000	50,000	60,000
Elongation	28 p. c.	23 p. c.	23 p. c.	25 p. c.	2[illegible] p. c.
Contraction of area	50 p. c.	40 p. c.	50 p. c.	50 p. c.	60 p. c.

In naming the above qualities in tempered material the sectional thickness is assumed to be considerable, say 3 inches and above; when the thickness is reduced to, say, 1 to 1½ inches the elastic limit of simple steel can be raised to about 55,000 to 60,000 pounds, and of nickel steel to 65,000 or 70,000 per square inch, without reducing the ductility.

Painting Freight Cars by Compressed Air.

The economy of compressed air in painting railway equipment was discussed at the February meeting of the New England Club. Mr. D. W. Smith, Wellsville, O., stated that by its use the body and roof of a 34-foot box car can be given its first coat in 24 minutes, its second coat in 20 minutes, and that a gondola car body, with 44-inch sides, can be painted in 10 minutes for each coat. He also said that the apparatus used less material than painting by hand, and that the operator has complete control of the flow of paint and can apply a heavy or light coat as desired. Mr. C. E. Copp had seen four kinds of painting apparatus, and while without extended personal experience with any of them, he believed that the use of compressed air for applying paint to freight equipment was bound to become general. He also gave 10 minutes as the time required to paint a coal car body. He said that in the open air in cold weather trouble had been experienced with ice in the pipes and valves, and to remedy this warming of the air has been considered. The paint also has a softening action on the interior of the hose, which difficulty must be overcome. He believed the paint was worked into the pores of the wood better than if applied by hand. Mr. Quest, of the P. & L. E. Railroad, gave the following estimated cost of work done in his company's yard as compared with painting by hand under the piece-work system:

	Piece work.		With spray.		Saving.		
	Hours.	Cost.	Hours.	Cost.	Hours.	Cost.	Per cent
Box	3½	.60	¾	.15	2¾	.45	75
Coal	1½	.30	¼	.10	1¼	.20	66⅔
Coke	3	.50	½	.12	2½	.38	76
Flat	½	.10	1/6	.05	⅓	.05	50
Trucks, all cars	....	.30	....	.12	....	.18	60
Roof only, box cars	....	.10	....	.04	....	.06	60

Mr. J. H. Kahler, of the Erie Railroad, has had two spraying nozzles and 200 feet of one-half inch hose in operation for two years, and he believes thoroughly in the method. It not only saves time, but gets the paint into corners, angles, tongues and grooves, etc., better than by hand. Mr. G. H. MacMasters gives the following comparison of the old and new methods:

Priming new 35-foot box car by hand—

Labor, 2 hours, at 20 cents	$0.40	
Material, 14 pounds paint, at 5 cents	0.70	
Total		$1.10

Priming new 35-foot box car with spraying machine—

Labor, 35 minutes, at 20 cents per hour	$0.12	
Material, 12 pounds, at 5 cents	0.60	
Total		$0.72
Total saving of		$0.38

Or 34.57 per cent.

Saving of labor painting by spraying machine, 28 cents, or 70.83 per cent. Saving of material painting by spraying machine, 10 cents, or 14.29 per cent. Roof and trucks not included.

As for the apparatus, that employed on the P. & L. E. Railroad seemed to meet with the greatest favor, though others are mentioned in the proceedings. Mr. Hodge, of the Santa Fe, presented drawings of the apparatus used by him. The Bryce Pneumatic Paint Machine was also mentioned.

Details of the Compound Mastodon Locomotives for the Northern Pacific Railroad.

Last month we published a full-page engraving and a description of the large compound mastodon or 12-wheeled engines built for the Northern Pacific Railroad by the Schenectady Locomotive Works. We have since received from the builders several detail drawings, some of which we reproduce herewith.

From their great size the cylinders are of more than ordinary interest. The low-pressure cylinder and half saddle are shown in Fig. 1, and one view of the high-pressure cylinder is given in Fig. 2 (p. 124). The latter cylinder is 23 inches in diameter and 30 inches stroke, and is supplied with steam at 200 pounds' pressure. Its ports are 20 inches long. The low-pressure cylinder is 34 inches in diameter and 30 inches stroke, and its ports are 23 inches long, the admission ports being 2¼ inches wide, and the exhaust 3 inches wide. The difficulties encountered in finding room for such a large cylinder are illustrated by the method adopted for bolting it to the frames. The cylinder centers are 86 inches apart, and the frame centers are only 43½ inches, and yet the bore of the cylinder is only 2¼ inches away from the frame at its nearest point. It was therefore impossible to follow the usual practice of passing the horizontal bolts securing the cylinder to the lower rail of the frame through a flange on the cylinder casting extending down the outside face of the frame.

The expedient was resorted to of drilling the bolt-holes completely through the wall of the cylinder, counterboring on the inside for the boltheads, and putting the bolts in from the inside. There are seven bolts inserted in this manner, a detail of which is given in Fig. 1. The heads are round, with a circular groove in each, and they are tinned before being put in place. When in position babbitt is poured around the heads and the metal finished off smooth with the bore of the cylinder. This is a novel method of securing a cylinder, but we understand that it has been used before with entire success either by these builders or by the Richmond Works.

The cylinders are made very strong throughout, and the fastenings to the frames and the boiler are substantial. The exhaust is partly in one half-saddle and partly in the other. The joint between the two castings is made steam tight by a thickness of varnished paper.

The intercepting and separate exhaust valves are of comparatively new designs recently perfected by Mr. A. J. Pitkin, Vice-President and General Manager of the Schenectady Locomotive Works, and Mr. J. E. Sague, Mechanical Engineer for the company. They are designed to give an independent exhaust to the high-pressure cylinders when the locomotive is working as a simple engine, and also to give the engineer control of the intercepting valve so that he can operate the engine simple or compound at will. In Fig. 3 a longitudinal section through the valve shows the parts in the position they assume when the engine is working simple, and in Fig. 4 a similar section shows the parts in the position for working compound. With the arrangement of valves shown

in these figures, the engine can be started and run either compound or simple, and can be changed from compound to simple or from simple to compound at the will of the engineer, with any position of throttle, and at any point of cut-off. The part which each valve does in accomplishing this is as follows:

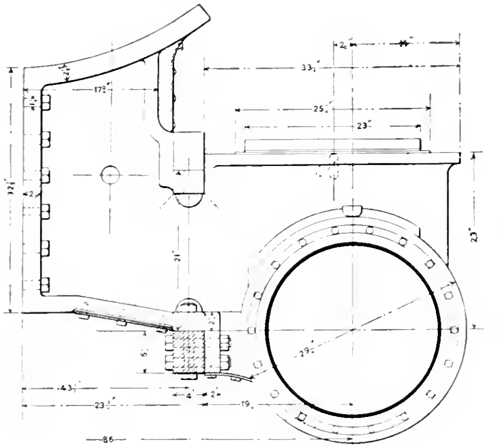


Fig. 2.—High Pressure Cylinder.

The separate exhaust valve when open allows the steam to exhaust direct from the high-pressure cylinder to the atmosphere without going through the low-pressure cylinder, thus working the engine simple, and when closed, causes the steam from the high-pressure cylinder to go through the low-pressure cylinder, thus working the engine compound. The intercepting valve closes the passage between the cylinders when the separate exhaust valve is opened, so that steam connot go from the high-pressure cylinder to the low-pressure cylinder, and it admits steam to the low-pressure cylinder direct from the dry pipe through the reducing valve. When the separate exhaust valve closes, the intercepting valve opens the passage between the cylinders and cuts off the supply of steam from the dry pipe to the low-pressure cylinder.

The reducing valve works only when the engine is running simple, and throttles the steam passing through it, so that the pressure of steam going to the low-pressure cylinder is about one-half the steam pressure in the dry pipe.

The intercepting and reducing valves are worked automatically by the steam pressures acting on the difference of areas of the ends of the valves, and their movement is cushioned by dash pots. The separate exhaust valve is operated by the engineer, by means of a three-way cock in the cab. To open the separate exhaust valve, the handle of the three-way cock is thrown so as to admit air or steam pressure against the piston *J*. Pulling the handle back relieves the pressure against *J* and the spring, which is shown in the figures, shuts the valve. All the engineer ever has to do in connection with the operation of the valves is to pull the handle of a three-way cock in the cab, one way or the other, according

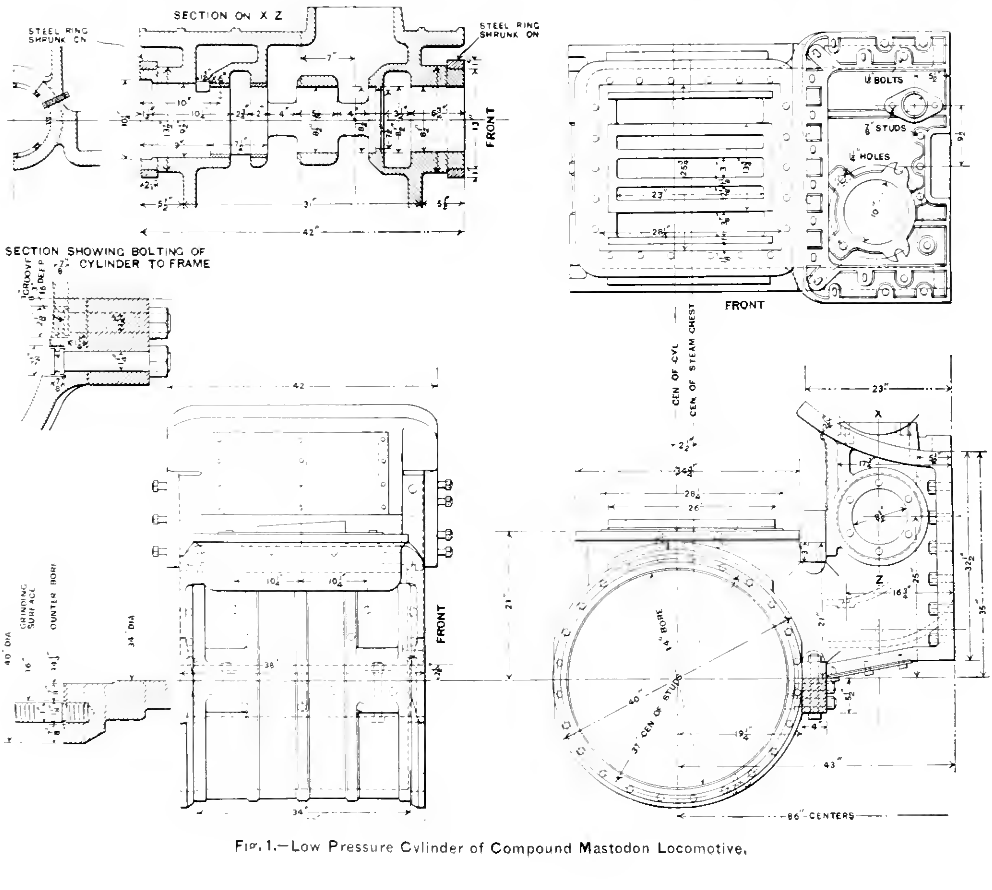


Fig. 1.—Low Pressure Cylinder of Compound Mastodon Locomotive.

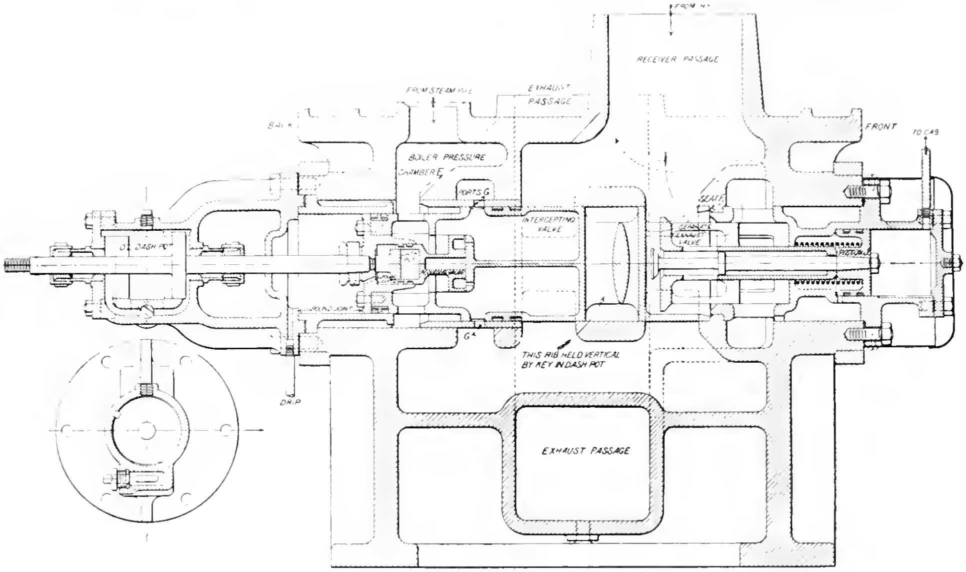


Fig. 3.—Intercepting Valve in Position of Simple Working.

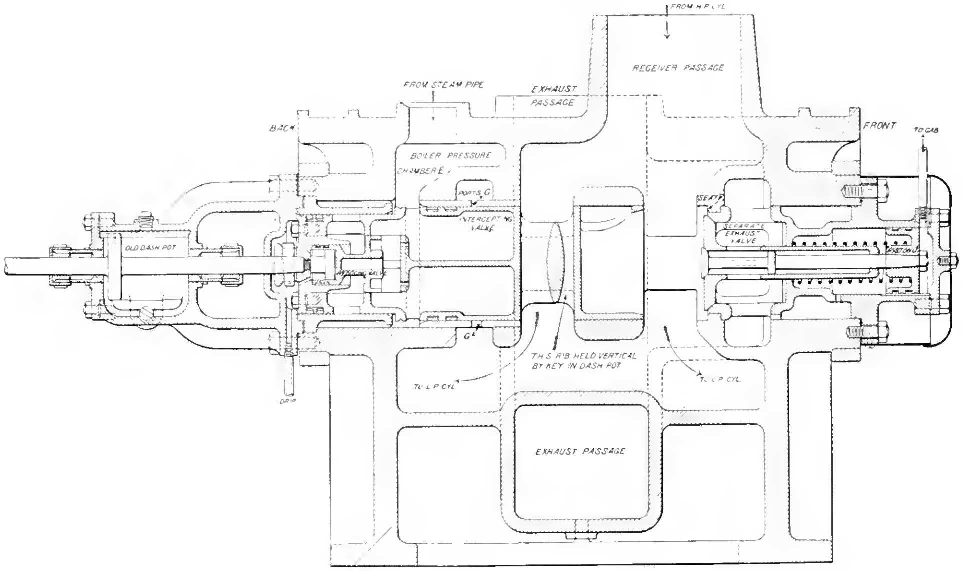


Fig. 4.—Intercepting Valve in Position for Compound Working. Schenectady Locomotive Works.

as he wishes the engine to run simple or compound. The engineer uses this handle under the following conditions:

First, to start simple. Under ordinary conditions this is not necessary, but if the maximum tractive power of the engine is to start a heavy train, the engineer pulls the handle of the three-way cock so as to admit pressure on the piston *J*. This will force the piston *J* into the position show in Fig 3. which opens the separate exhaust valve and holds it open, As soon as the throttle is opened, steam at boiler pressure enters the chamber *E* and forces the intercepting valve against the seat *F*, as shown in Fig. 3. Steam enters the high-pressure cylinder, and is exhausted through the receiver pipe and separate exhaust valve to the atmosphere, as shown in Fig. 3. Steam also enters the low-pressure cylinder from chamber *E*, through the reducing valve and ports *G*, and is exhausted in the usual way. The steam is prevented from reaching the low pressure cylinder at boiler pressure by going through the reducing valve. As will be seen from Fig. 3. the valve is partly balanced by the cylinder open to the atmosphere, and the boiler-pressure acting on the unbalanced area throws the valve to the right. When the pressure on the right of the valve becomes

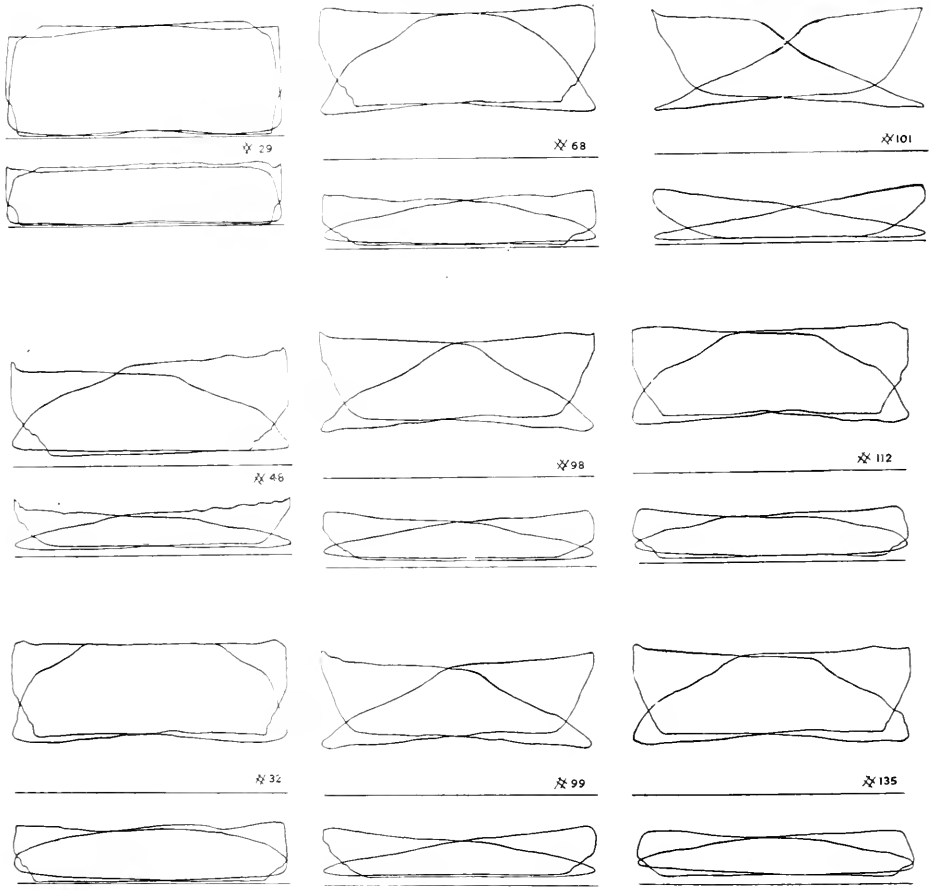


Fig. 5.—Indicator Cards From Compound Mastodon Locomotives.

high enough it will throw the valve to the left, because it acts on the whole area of the valve, and in so doing throttles the steam to the proper pressure for the low-pressure cylinder.

Having started the train in this way, when the engineer wishes to change the engine from running simple to running compound, he pushes the handle of the three-way cock to its first position, which relieves the pressure on the right of the piston J and the spring throws that piston to the right into the position shown in Fig. 4, closing the separate exhaust valve. As soon as this valve is closed the pressure in the receiver rises and presses the intercepting valve to the left against the pressure in chamber E, which only acts as an unbalanced area of the valve. The receiver pressure holds the intercepting valve to the left, as shown in Fig. 4, closing the ports G and opening a free passage from the high-pressure cylinder to the low-pressure cylinder, and the engine works compound.

It will be noticed that, while working compound, which is the usual way of working the engine, the intercepting and reducing valves are both held against ground joint seats which prevent the leakage of steam that may have leaked past the packing rings.

Now with the engine running compound, if the engineer wishes to run the engine simple, because of a heavy grade, he pulls the handle of the three-way cock the same as for starting simple. This will open first the by-pass valve K, and then the separate exhaust valve, the by-pass valve relieving the pressure more gradually than if the large valve was opened at once. As soon as the separate exhaust valve is open the pressure in the receiver drops, and the intercepting valve is forced against the seat F by the pressure in chamber E, and the engine runs simple as before. When the grade is passed the engineer pushes the handle of the three-way cock over and the engine begins to work compound. To start the engine compound the separate exhaust valve is left closed, as in Fig. 4, and when the throttle is opened the intercepting valve will be forced against the seat F by the pressure in chamber E, as shown in Fig. 3. The low-pressure cylinder will then take steam through the ports G, and the high-pressure cylinder will exhaust into the receiver for a few strokes of the engine. This will raise the pressure in the receiver and force the intercepting valve into the position shown in Fig. 4, closing the ports G, and the engine will run compound.

The combination of the automatic intercepting valve with the separate exhaust valve permits the engine to be changed from simple to compound, and the reverse, very smoothly and without danger of jerking the train, and in recent tests the engine was changed from compound to simple and the reverse repeatedly, when operating at a maximum power, with the throttle remaining wide open.

When the first of these four engines were built it was given a trial trip on the tracks of the New York Central road. Going out of Schenectady there is a 60-foot grade to surmount, and in Fig. 5 we show a number of diagrams taken from the engine on that

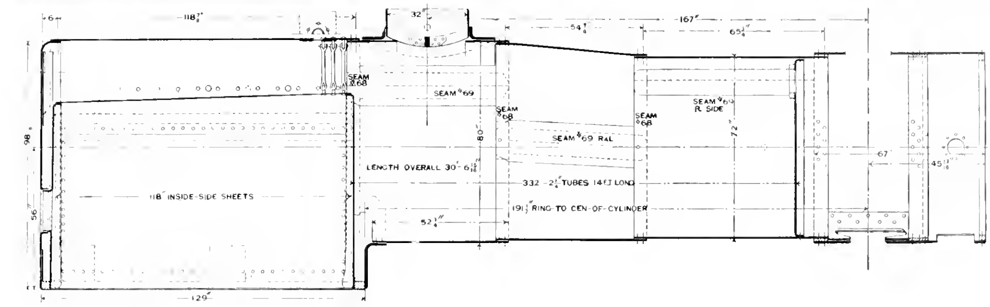


Fig. 6.—Boiler for Compound Mastadon Locomotive.

grade. The data relating to the diagrams is given in the accompanying table:

DATA FOR INDICATOR DIAGRAMS GIVEN IN FIG. 5.

No. of card.	Revolutions per minute.	Miles per hour.	Piston speed in ft. per min.	Steam pressure.	Horse power.	Per cent. of work done by L. P. cyl.	Position of throttle.
29	20	3.3	100	200	349	54.1	½ open.
48	90	14.7	450	200	960	49.6	½ "
32	56	9.1	280	200	818	55.1	wide open
68	64	10.4	320	201	785	51.2	¾ open.
98	102	16 7	510	200	1,015	54.0	wide open.
99	118	19.3	590	195	1,097	55.7	" "
101	114	18.6	570	195	904	56 7	" "
112	86	14.1	430	195	1,001	52.0	" "
135	112	18.3	560	195	1,220	52 0	" "

It should be noted that diagrams 29 and 48 were taken while the locomotive was working as a simple engine. All the diagrams are of interest as being taken from what is probably the largest pair of compound cylinders thus far introduced into locomotive practice. The enormous power of the engine can be realized when it is noted that at a speed of only 18.3 miles per hour it indicated 1,230 horse-power. The tractive effort at the rail in this case (card No. 135) can be calculated thus:

$$\frac{33,000 \times 1,230 \times 60}{5,280 \times 18.3} = 25,125 \text{ pounds,}$$

from which must be deducted the engine friction, which, if taken at 12½ per cent. of the total power, leaves a tractive effort at the rails of about 22,000 pounds. This is enormous for a speed of over 18 miles per hour. Performing the same calculation for card No. 29, taken with the engine working simple, and we find the tractive effort, after deducting engine friction, to be in round numbers 35,000 pounds. This figure indicates what may be expected from this engine at slow speeds, as shortly after starting, or when working on heavy grades. As the weight upon the drivers is 150,000 pounds, it is interesting to note that the ratio between that weight and the tractive effort at the moment the card referred to was taken was 4.14 to 1. This figure ought to interest one of our English contemporaries, who assumes a ratio of 6 or 7 to 1, and then cannot understand why American locomotives can exert such large tractive efforts.

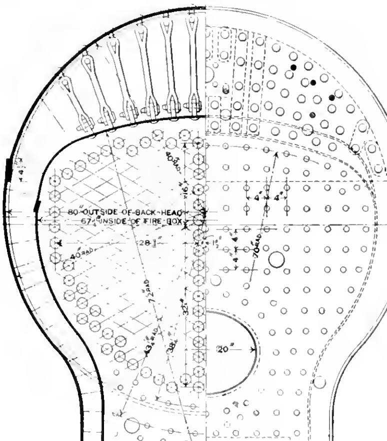


Fig. 7.—Boiler for Compound Mastadon Locomotive.

Though we do not illustrate the frames of this engine, a few

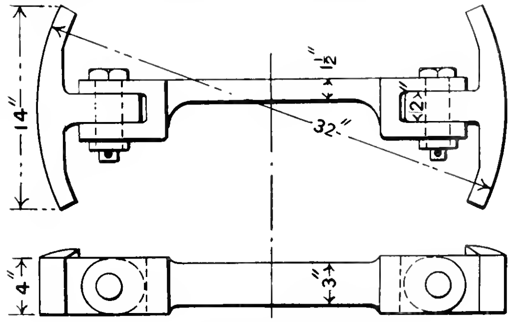


Fig. 8.—Brace at Base of Dome.

facts regarding them may not be out of place. They are 4½ inches thick throughout, except at the cylinders and forward of them where the thickness is 4 inches. The top rail is in general 4 inches deep, and the bottom rail from 2½ to 3½ inches deep. Over the driving boxes the top rail is 5½ inches deep and the pedestals are closed at the bottom by thimbles and 2¼-inch bolts. At the cylinders the top and bottom rails are separate forgings, each 5¼ inches deep. Just back of the cylinder saddle there is a spacer between them 22½ inches long.

The boiler, shown in Figs. 6, 7 and 8, is notable chiefly for its great size and the high pressure carried—200 pounds. It is of the extended wagon-top, radial-stay type, and though nominally 72 inches in diameter, is in reality 80 inches in diameter for considerably more than one-half of its length. For particulars regarding heating surfaces, etc., we refer our readers to our article last month. The staying of the boiler conforms to modern practice for this type. We would, however, call attention to the manner in which great strength is secured at the base of the dome. In addition to the modern custom of using a very heavy ring flanged both ways at the base of the dome, there is a heavy cross-tie (see Figs. 6 and 8) extending across this ring to prevent any deformation at this point—a wise precaution in view of the large diameter of the boiler at that point and the high pressure carried.

(Established 1832.)

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

28TH YEAR. 66TH YEAR.

PUBLISHED MONTHLY
BY
R. M. VAN ARSDALE,
MORSE BUILDING..NEW YORK

M. N. FORNEY, W. H. MARSHALL, } Editors.

APRIL, 1897.

Subscription.—*$2.00 a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union.*

EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Special Notice.—*As the* AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL *is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 25th day of each month.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* **When a subscriber changes his address** *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

The paper may be obtained and subscriptions for it sent to the following agencies: **Chicago,** *Post Office News Co., 217 Dearborn Street.* **London, Eng.,** *Sampson Low, Marston & Co., Limited St. Dunstan's House, Fetter Lane, E. C.*

The brief article on another page of this journal is illustrative of the tendency to use higher carbon steels in forgings, plates and other forms in which the material is employed in machine construction and structural work generally. Undoubtedly this movement is to be commended. In the earlier days of steel it was considered unreliable and mysterious in its action, and one of the greatest safeguards against sudden fractures was supposed to be a low tensile strength and the accompanying great ductility. It is now known that careful working from the moment the ingot is cast until the product is finished is necessary to secure sound material, and that this being obtained the chemical composition can be safely made such as to secure the desired tensile strength for any given case. Engineers are also beginning to understand that the methods of obtaining the elastic limit have in the past been faulty and that in many cases the true elastic limit is considerably less than the figures which have been used by them in determining the strains to which the material will be subjected. The belief is, therefore, growing that higher carbon steels with their greater ultimate strength and higher elastic limit are better for many classes of work than those soft steels the elastic limit of which is so low that either the strains which they are to endure must be smaller than is economical or the danger of occasionally exceeding the elastic limit will become too great. In other words, a good high carbon steel with a large actual factor of safety is better than a low carbon steel with a smaller factor of safety.

The decision of the Arbitration Committee of the Master Car Builders' Association in the case of the Rock Island against the Lake Shore road, found elsewhere in this issue, is of more than ordinary importance. The case is one of wrong repairs made on a Rock Island car by a third road, and for which the Rock Island held the Lake Shore responsible when the latter delivered the car to it. The Rock Island held the opinion that, as a road was called upon, under the rules, to give the same care (including inspection) of foreign cars as of its own, such inspection is the only safeguard against wrong repairs that have not been carded, and an intermediate road failing to discover the wrong repairs should be held responsible. The Arbitration Committee also held this view, and so ruled. This ruling appears to be both wise and just, but it nevertheless institutes an inspection that is not for safety alone, and to that extent is in conflict with the spirit of the new interchange. On the other hand, it must not be forgotten that there is a vast difference between "inspection for protection," which dealt with a thousand and one small matters that arose through honest differences in the interpretations of the old rules, and an inspection which, after safety, seeks only to guard against the carelessness of those who make wrong repairs and do not card for them.

A very strong argument in favor of a more exact determination of the elastic limit in testing steel is given by Mr. P. Kreuzpointer in recent issues of the Iron Age. Three definitions of the term elastic limit must be borne in mind, viz., the load which does not produce permanent set, the limit of proportionality of stretch, and the visible limit at which a visible stretch takes place without a noticeable increase of load, and which shows itself by the drop of the beam of the testing machine. The difference between the visible elastic limit and the limit of proportionality is of vital importance, for when the latter figure is exceeded in service, it is apparent that the material is already undergoing structural deterioration and must be relieved of strain or it will ultimately fail. Tests are quoted to show that in 84,000 pounds steel this limit of proportionality was as much as 6,900 pounds less than the visible elastic limit. In another case it was 6,200 pounds. In some tests of iron it was 1,500 pounds. Tests made by Professor Bauschinger on 1-inch round iron showed an average difference of 6,775 pounds per square inch, one piece rising to 8,750 pounds. On Bessemer steel he found that with an average visible elastic limit of 39,000 pounds the limit of proportionality was 4,980 pounds less. This average is made even more significant if we look at the individual tests, for we find the differences ranging all the way from 1,300 to 12,400 pounds. Thus if we attempt to employ steel with a visible limit of 40,000 pounds and its limit of proportionality (though we may not know it) is only 28,000 pounds, it is evident that the metal may be subjected to stresses too great and these may be repeated so frequently as to give insufficient time for elastic reaction. Under such circumstances failure is certain. At all events it is clear to every competent engineer that safety lies only in definite knowledge, and such an indefinite figure as the visible elastic limit, inaccurate in itself, and rendered more inaccurate by the manner in which it is obtained, can never be as safely used as a basis for the determination of allowable stresses as can the limit of proportionality. The subject is so important that it calls for much more attention than it is receiving at present.

In a valuable paper on lead for locomotives read by Mr. C. H. Quereau before the Western Railway Club, in February, some excellent reasons are given for abandoning the present practice of setting valves with a given amount of lead in full gear, regardless of the proportions of the valve gear or the steam distribution at the average working cut-off. Probably there are almost as many differences in opinion to-day regarding valve setting as in times past, and even among those who advocate reduced lead at the running cut-off several methods of accomplishing the result are advocated. But the unanimity on the advantages of reduced lead is significant. The different methods consist in getting the reduced lead at the working cut-off either

by (1) setting the valves in full gear with equal leads in front and back motion, (2) with more in the front than in the back, or (3) with less in the front than in the back motion. The author states that "careful experiments with full size valve-gear models, plotting the results enlarged eight times, shows that with a given valve gear the steam distribution for 6-inch cut-off is the same so long as the lead for that cut-off remains the same, no matter in which way the full gear lead is set." The different methods of setting do, however, affect the power at intermediate points of cut-off, and the author is of the opinion that "it is better to make the full gear lead for forward motion either line and line or slightly negative. In my opinion it should never be more than 1-16 inch positive for a plain valve or 1-32 inch positive for an Allen valve, and less than these amounts will increase the power of the engine. When the proportions of the valve gear are such as to allow the correct lead for the running cut-off and at the same time secure a full gear lead not greater than 1-16 inch positive or less than 1-16 inch negative for plain valves, nor greater than 1-32 inch positive or less than 3-32 inch negative for Allen valves, I would prefer to make the full gear lead the same in both front and back gear. Except in rare cases where the link radius is excessively long, the third method has no special advantage, and is probably objectionable because it reduces the port opening for cut-offs longer than 6 inches more than is desirable. Where the radius of the links is less than about 50 inches, and the engines do most of their work in forward motion, the second method is probably the best." The essence of the matter seems to be that if one will set valves with the idea of getting the right lead at the working cut-offs, a distinct advantage in smooth working, increased power and even economy of coal will result; furthermore, that if this calls for negative lead, no harm will result; and lastly, that any of the three methods of valve setting in full gear may be found best under special conditions, but that the second method is preferable for the average locomotive.

PIECE WORK PRICES.

In conversation recently with a prominent superintendent of motive power the question of piece work came up, and he objected strongly to the practice of some officials who before introducing it in their shops send to other roads for their price lists. The official refered to has no objection to making public the prices paid in his shops, but he has found that often such prices are an incentive to others to "go one better" regardless of the normal prices of labor in the two places. This is wrong and if persisted in will only bring piece work in bad repute. In deciding upon the prices to be paid by the piece each shop must take into consideration the prices for labor in the market from which it gets its supply. All other things being equal the piece work price for planing a crosshead should not be the same in a shop located where good machinists get 30 cents per hour as in a shop where 22 cents per hour would be a fair price. If they were the same, either the men would be getting too much in one case or the company would be getting too much in the other.

It is conceivable that the piece work prices in a locality where labor is high may be more than the cost of similar work by the day plan in communities where labor is cheap, but that has nothing whatever to do with the fixing of just and equitable prices in either place. Each case must be dealt with on its own merits. Granted that a shop heretofore operated on the day plan has been run economically, and that piece work is now contemplated, the prices should be so adjusted that the company and the men will each profit by the change, and to about an equal degree. When this has been done the men will be satisfied, and the company *should* be satisfied regardless of what somebody else pays for similar work. Further economies will be achieved, but they will come from the introduction of improved machinery and methods. One shop which we have in mind has the excellent rule that when the price for a certain piece of work has once been established to the satisfaction of all concerned, the company will make no change in it one way or the other, unless it changes the shape, size or material of the piece, makes a capital outlay for improved machinery or tools, or makes a radical change in its methods of doing the work. Add to this a rule that all improvements in methods and machinery originating with the men shall benefit the latter to the extent of giving them a fair share of the resulting profits, and it would appear as if the company had enlisted all its forces in the interests of economy.

But to go back to the starting point, if somebody else's practice and prices are used as a guide, see to it that due allowance is made for the differences in machinery, in the labor market, and in all that is necessary to consider in arriving at prices fair to the men and the company.

ROLLER BEARINGS.

The present time appears to be marked by another period of activity in the development of roller bearings for such trying work as steam and street railway work. It is within the realms of possibility that some day a successful roller bearing for that work may be found, but we feel that many who have hopes in this direction do not stop to fully consider the difficulties in the way.

The advantages of roller bearings over present practice are supposed to lie in the substitution of a rolling for a sliding contact, with all the attendant benefits of reduced friction, and absence of lubrication and wear. The theory is beautiful, but the construction of a practical bearing is another matter. Two almost insurmountable difficulties appear at once: one is to keep the rolls parallel to the journal so that the theoretical line of contact be not reduced to a point, and the other is to so space apart the various rolls as to prevent them from rubbing on each other. It may be asserted, without fear of contradiction, that seldom has a roller bearing been designed in which these requirements were met without introducing sliding contacts somewhere in the structure. Some bearings have been designed in which the main rolls were spaced by secondary rolls which also had a rolling contact on a fixed part of the box in which the main rolls revolved. But it is evident that in such a design there is nothing to resist any tendency of the rolls to get out of parallelism with the journal. In fact, they might all stand at an angle to the journal and be parallel to each other. Not only is it possible for them to get into this position, but they actually get there, and then the end thrust of each roll causes trouble (for such end thrust is generally resisted by sliding contacts), and it is furthermore evident that the purely rolling contact between the rolls is converted into a mixed sliding and rolling contact, while the contacts on the journals are mere points, not lines. Again, as the journal, rolls and box wear (for they do wear), the general looseness of parts permits the evils mentioned to increase rapidly. Then we have enough grinding and cutting of parts to spoil all the fine friction records which bearings furnish when new.

Other bearings have been designed in which the spacing of the main rolls has been attempted with a view of also keeping them parallel with the journal. In such cases the spacing mechanism has usually been carried by what has been called a "cage," consisting of two rings between which the main rolls run, and which are riveted together by studs long enough to give the rolls some end motion between the rings. The rolls are generally guided in the straight path of duty by secondary rolls, which, in turn, are held in line by an arrangement which involves sliding friction among these parts. We once had some experience with a bearing of this class, which made more than 100,000 miles under a 55,000-pound coach, and while the main rolls behaved in a creditable manner when new, the secondary rolls wore rapidly. When worn so much as to fail in their duty of guiding the main rolls, the latter would seek devious ways, and act in total disregard of all the good things their owner had said about them. We have known one-half an inch to be worn off the end of a roll 3¾ inches in diameter, in a few hundred miles, and the other rolls in the same box to be not far behind that record. These boxes were supposed to run be without oil, for that was one of the economies claimed for them, but the parts were always soaked in oil when

first fitted up, and when end wear of the rolls appeared they were invariably treated to a dose of graphite.

Any good mechanic who studies the requisites of a good roller bearing will recognize the need of keeping the rolls absolutely in line. To do this he will see that the main rolls will need to be held either by rolls or balls. If rolls, then these in turn must be kept in line by other rolls or balls, and so on indefinitely, if sliding friction is to be avoided. Furthermore, adjustment for wear must be provided, even if balls are used in place of secondary rolls. Then, while the end thrust of the axle can be taken care of independently of the rolls, the bodily lateral movement of the latter must be prevented. After all this has been done, we will have a device that rivals a clock in the accuracy of workmanship, and in which there are many points where sliding friction or imperfect adjustment will get in their insidious work.

What we have said against the practicability of roller bearings is meant to apply only to heavy pressures and high speeds. Evidently, under such conditions, all defects are exaggerated and the greatest accuracy of alignment is necessary. For many other purposes roller bearings might be made a success. A roll made out of square steel wound in helical form, brought out some years ago, has a flexibility which ought to make it very satisfactory for uses to which rollers are really adapted. When the alignment in the bearing is not perfect, either because of workmanship or wear, the bearing of such a roll is not a mere point, but continues to be a line under all ordinary conditions, and the material is well adapted to resist cutting and any tendency to excessive wear.

COMPRESSED AIR AND ELECTRICITY.

At the June Convention of the Master Mechanics' Association, a report is expected on the subject of motors for shops—steam, air and electric. The practical abandonment of steam motors for all purposes outside of the main power plant is so general that we may expect the report to be largely devoted to compressed air and electricity. It is an interesting subject and if the committee will realize that there is a field for each of these types of motors and will as far as possible define those fields, a valuable work will have been accomplished. To an impartial mind, both compressed air and electricity appear as valuable agents for the transmission of power. Both have the advantages of small loss in transmission and of conductors at the temperature of the surrounding atmosphere and suitable for almost all places and positions. In the storage of power compressed air appears to have an advantage over its competitor. When, however, we come to utilize the power transmitted we are at once confronted with the fact that electricity can be used satisfactorily only where a rotary motion is suitable to the work in hand, while the forte of compressed air is not rotary but reciprocation motion. The relative values of the two agents consequently depend not altogether upon the methods or economy of generating and transmitting the power by each, but somewhat upon the facility with which each can be employed at the various points and to the work for which the power was generated. Under these circumstances it would appear almost axiomatic and entirely beyond dispute that each of these agents has its legitimate field. At present there seems to be a disposition on the part of the advocates of each to urge the use of one to the exclusion of the other, but we venture the prediction that in the near future large shops will be equipped with both electricity and compressed air for power purposes. Why not? This present hustling after compressed air tools, much as it is to be commended, does not arise from the fact that it is superior to all known agents for all purposes, but because it is much cheaper than the manual labor it replaces; in fact, the cases are legion where compressed air is generated and used in a thoroughly wasteful fashion, and yet saves much money when compared with former methods involving more manual labor. When we get far enough into the new order of things to be more concerned in how much more we can save than in the good work already done, the wasteful methods of using air will not be tolerated, and where the use of electricity is the proper solution for individual cases, that agent will surely be employed. Then we will find electric generators and air compressors both installed in the one plant, and each time it is decided to employ power for certain operations formerly done by hand, the agent more suitable for that particular case will be selected. Such a course will not result in reducing the extent to which compressed air is used, for the employment of both air and electricity are bound to extend greatly as the result of the ever pressing demand for economy in shop operations.

RAILWAY ENGINEERING.

We publish elsewhere the courses and lectures in railway engineering which Purdue University offers for the year beginning in September, 1897. We call particular attention to it because in our opinion it embodies the only practical method by which our universities can meet the demand for a special technical training for young men who intend to engage in the "railway profession;" not that this excellent course thus outlined is wholly perfect, but because it is based upon a right conception of how the technical training mentioned shall be given, and because it represents the best judgment of a university faculty that has done more in providing opportunities for railway technical education than any other.

If ever some of the special courses suggested by several writers, which apparently aim to give young men the general knowledge required to fit them for positions of managers and presidents, are undertaken we believe they will fail. Men are not fitted for positions of responsibility in that manner. On the contrary, almost every man of high position has prepared for his present duties by labors in one of the several departments he now controls. He leaves his narrower field for a broader one, because in his administration of the affairs of one department he has exhibited an executive ability and a breadth of view that has enabled him to make that department part of one harmonious whole. Specially trained in one line of work, he has taken a comprehensive view of railway operation as a whole and understands the sphere of each department and its proper relation to the others. Able men of that stamp can advance from the special work, whether that be traffic, civil or mechanical engineering, or anything else, into broader fields of usefulness, and that, too, without a general collegiate education for the "railway profession." In fact, we believe that courses such as Purdue has outlined, particularly if so administered as to lead the student at each step to see the relation of his own chosen calling to the other professions and to the great commercial and industrial enterprises of the times, furnish the best of educations to men destined to occupy advanced positions. We are reminded of the case of a civil engineer of prominence who, in middle life, found himself at the head of great railway traffic interests, and who confided to an acquaintance his opinion that he was then still following his profession. He found that the training which made him successful as an engineer enabled him to view other business problems from all sides, and that underlying the honest administration of all great interests there were the same general principles.

There is another consideration which must not be overlooked in this connection. No university education, however complete, will ever fit a man for the immediate control of great business interests. He must have practical experience first. Where will he get it? If his education has been along the line of railway management only, will somebody entrust a great property to him while he is getting the practical experience? Is he not more likely to find lucrative employment within a reasonable time after graduation if his education has been along the line of some of the professions with an insight into what we will term administration? We have already stated in these columns our opinion that if the great transportation interests of this country are as great a factor in commercial, industrial and social life as most of us believe they are, we need not the educational courses on railways that will appeal to the few, but rather such courses in every university as will interest the many. We, therefore, welcome the broader work of Purdue in railway engineering as a practical example of this kind, and with the assurance that its excellent record in the past is a guarantee of the quality of its future work.

A NEW RECORD-BREAKING STEAMSHIP.

At last the dimensions of the *Great Eastern*, noted chiefly as being the largest steamship ever built, are to be exceeded by a new trans-Atlantic steamer. The White Star Line has arranged with Harland & Wolff, of Belfast, for the construction of a steamer 704 feet long, which, if this measurement is taken on the water line, is 24 feet longer than the *Great Eastern*, and about 65 feet longer than any of the large steamers now in the passenger service on the Atlantic. The boat will be about 70 feet beam, and its gross tonnage will exceed 17,000. In another respect the new steamer will claim distinction, and that is in the power of its engines. The *Oceanic*, as the boat is to be called, will be propelled by three screws driven by three sets of engines aggregating between 45,000 and 50,000 horse power. The greatest power thus far placed in a steamer is the 30,000 horse power of the latest Cunarders. The enormous increase of power in the new boat is perhaps better realized if we stop to think that it is more than double the power in many of the great boats that are capable of making 21 knots at sea. The development of this power will entail an enormous coal consumption, estimated at 700 long tons per day. This is at the rate of 1.5 pounds of coal per horse power per hour for 45,000 horse power. The ship will have to carry about 4,000 tons of coal when leaving port. It is said the boat is to have a speed of 27 knots.

The steamship company do not claim this speed for the boat however. They say that the attention will be given to the matter of speed, but extreme speed will be subordinated to the comfort and convenience of passengers of all classes; and in her internal arrangements the new vessel will be an enlarged reproduction of the *Teutonic* and *Majestic*, except in so far as improvements may have suggested themselves in the size and fittings of the rooms, and which may be rendered practicable by the increased dimensions of the ship herself. Upon this question of speed the company state that although a much higher sea speed than that now contemplated is quite practicable from an engineering point of view, it has been determined as far as possible to aim at a regular Wednesday morning arrival, both in New York and in Liverpool, making the Irish land and Queenstown by daylight, and enabling passengers who may be traveling to places beyond the port of arrival to proceed to and in the majority of cases reach their destinations with comfort during the day. It is expected that the new *Oceanic* will be launched in January, 1898. Her advent will be regarded with interest. As illustrating her utility to the British Government in case of war it may be stated that in the matter of coal endurance her powers are to be most exceptional, inasmuch as after making liberal allowance for the weights of stores, ammunition and troops, the boat will be able to steam 23,400 knots at 12 knots per hour, or practically round the world without coaling. This great passenger and mail steamer going into service in 1898, and the huge freight steamer *Pennsylvania* of the North German Lloyd, which completed its maiden trip last month, will hardly be exceeded in dimensions during this century so near a close, and may therefore be considered as the greatest triumphs in their respective classes of nineteenth century marine construction.

NOTES.

At the March meeting of the Central Railroad Club a report was made in favor of piecework in railroad shops, including the work of car repairs.

On the 14th of January, 1897, the Society of Civil Engineers of France dedicated its new home in Paris, and in commemoration of the event has published a neat illustrated pamphlet descriptive of the building and giving briefly the history of the society since its organization in 1848.

Mr. Lucien Serraillier has compiled and Messrs. Whittaker & Company, Paternoster Square, London, E. C., will shortly publish a technical railway vocabulary, giving over 5,000 French, English and American technical terms used in railway management, construction and working. The book is destined for the use of engineers, railway men, contractors, company directors, financiers, lawyers, patent agents and inventors.

Government statistics show that during the fiscal year ending June 30, 1896, there were exported from the United States 261 locomotives, 1,750 passenger and freight cars and 14,635 car wheels. Of these, 34 locomotives went to countries on the North American continent, nine to the West Indies, 116 to South America and the remainder to countries beyond the seas; of the cars, 1,461 went to countries on this continent, 126 to the West Indies, 190 to South America and the remainder to countries beyond the seas.

The adoption of the tonnage system for freight trains on the Baltimore & Ohio Southwestern has resulted in quite a saving in the cost of transportation. General Superintendent Rawn states that locomotives, under this system, are pulling from two to seven more loaded cars per train than ever before. A very simple but comprehensive set of blanks has been furnished the Yard Masters, and in making up the trains each locomotive is given the number of tons which it has been demonstrated by experience it is able to haul. This system has also resulted in fewer complaints of locomotives being stalled with their trains on grades.

On the 18th of last month President Depew, of the New York Central road, had occasion to go from New York to Albany on a special train to keep an appointment. He ordered the special at 11:40 a. m. and it started at 12:22. It consisted of an eight-wheeled passenger engine, Mr. Depew's private car and one coach. Once clear of the tunnel and bridge and curves of the lower part of the road, the great race with time began. The 10 miles from Yonkers to Tarrytown were covered in nine minutes, the 30 miles from Spuyten Duyvil to Peekskill were made in 32 minutes, the 45 miles from Poughkeepsie to Hudson were made in 44 minutes, and from Hudson to Albany the 28½ miles were run in 29 minutes. The train arrived at Albany at 2:59, after a run of 143 miles in 156 minutes and 9 seconds. The run was made in four minutes less time than the schedule of the Empire State Express.

Last month we briefly referred to the special run made on the Chicago, Burlington & Quincy road from Chicago to Denver, Feb. 15. Particulars were received just as we went to press last month, from which it appears that the special was requested by wire from Fort Wayne by Mr. H. J. Mayhan, who was traveling on the Pennsylvania limited. The message was received at 8 a. m., but no arrangements were made until Mr. Mayhan arrived at about 9:15 a. m. Only two engines were in the roundhouse at the time, and the one taken was a light 17 by 24 that had been doing duty in suburban service. The train left at 10 o'clock, and without any special arrangements began its long run of 1,025 miles. The train men were instructed to make good time, but were given no record-breaking instructions. A total of 21 station stops were made on the run, consuming 64 minutes, besides 14 other stops made for railroad crossings. The actual time for the entire distance was 18 hours and 53 minutes, or an average of 54.27 miles per hour; deducting the station stops only, the running speed was 57.53 miles per hour. The single private car of which the train consisted weighed 72,000 pounds.

Those who remember the machine for dressing car wheels that was exhibited some five or six years ago in Chicago and was commonly spoken of as the Miltimore car-wheel dressing machine will be interested in a recent paper before the Canadian Society of Civil Engineers, in which several improvements on the machine are described. The machine, as exhibited some years ago, employed two large steel disks, whose rims were turned to the reverse of the standard flange and tread gage of the Master Car Builders' Association, and these were made to revolve at a very high speed, 3,000 revolutions per minute. When brought in contact with a pair of car wheels to be trued up, the latter being made to revolve slowly in the machine, the metal was quickly removed by friction and heat. One great trouble with the arrangement was that it required about 200 horse-power to operate it. From the paper alluded to, it appears that electricity has since

been employed for locally heating the wheel while being dressed, thus making it possible to reduce the power applied to the disks to that necessary to remove the metal already heated. The total power consumed has by this means been reduced somewhat, but hardly enough to bring the machine within the range of commercial success.

Within the past few days the Receivers of the Baltimore & Ohio road have prepared a statement of expenditures from March 1 1896, to Feb. 1, 1897, for additions to the plant, equipment of the road and betterments made thereon. From this statement it is learned that a total of almost seven millions of dollars have been spent for locomotives, passenger and freight equipment, extraordinary repairs to equipment and expenditures made by the Engineering Department in the way of improvements to the maintenance of way, structures, terminals and the construction of new alignments and miscellaneous improvements. Of this great sum nearly five millions have been expended on rolling stock and about two millions on permanent way. These figures do not include the order for 58,000 tons of 85-pound steel rails recently ordered and which will cost in the neighborhood of one million.

The experience of those using mechanical stokers appears to furnish another instance of wherein the "doctors disagree." According to Power, the Steam Users' Association has been seeking information on the subject. To the question "Do stokers save coal over hand firing?" one reply showed a loss in economy, five reported no saving, and six reported a saving. The balance could not tell. One plant reported a large saving due to using a cheaper grade of coal than could be fired by hand. In reply to the question "Do stokers save labor over hand firing?" one found increased cost in labor, three found no saving, and eight found a saving. Three of the first four thought they could arrange to make a saving if their plants were fully equipped. In reply to the question "Do stokers save smoke over hand firing?" two soft coal plants thought they did not, seven thought they did. As to repairs, only five had had stokers in use over two years and of these three replied that repairs were small or trifling; the other two did not reply to the question on repairs. Five thought they responded slower than hand firing to a call for steam; one equally as quick and five quicker; three thought they needed more draft; four the same, and one less draft than a hand-fired furnace; five did not intend to increase their use of stokers or had already discarded them, three were doubtful, while six intended to increase. No plant was able or willing to say whether there had been any net gain from their use of the stoker.

In a paper read before the American Society of Heating and Ventilating Engineers, by Prof. J. H. Kinealy, on the determination of the volume of air passing through a register, the author states that in determining the volume of air flowing through a register per minute it is customary to determine the velocity in feet per minute at the surface of the register by means of an anemometer and then multiply this velocity by either the area of the face of the register or some fractional part of this area. This involves two separate and distinct problems, as follows: 1. The determination of the velocity of the air by the anemometer. 2. The determination of the fractional part of the area of the face of the register by which the velocity should be multiplied. The author then describes the several methods in which the anemometer is ordinarily employed for this work and proceeds to describe some tests made by himself on a register 13¾ by 21¼ inches in area, the opening through which aggregated 60 per cent. of the total area of the face of the register. Readings were taken with the anemometer placed ½ inch above the register and moved to various positions over its area; also readings were taken on top of an airtight box 2 ft. high placed on the register and having the same area as the register. As a result of these tests the author finds that the fractional part of the area of the face of the register by which the velocity should be multiplied to get the total delivery of air from the register is about .80 for the particular case in point, and from later tests on other registers he is inclined to think that a good rule for all cases is to take one-half of one plus the ratio of area of openings to total area of register as the effective area. This will generally bring the factor between .80 and .85.

Of all of the lightships along our coast probably the South Shoals lightship, off Nantucket, has the most dangerous and at the same time the most important post. She has been torn from her moorings many times. That a chain and anchor could be made strong enough to hold any vessel against the winds and seas is probable, but the trouble heretofore has been that the great weight of such a chain tends to drag a vessel's head under the seas, and, although the chain might hold, the vessel either would be swamped or the unyielding nature of the chain would cause the vessel to tear away at the fastenings on her. To obviate this difficulty the Lighthouse Board has devised a new mooring, which is to be tried for the South Shoal lightship. The mooring chain is to be 200 fathoms long and of iron 1¾ inches in diameter. Instead, however, of having this great chain pass directly from the anchor to the ship, and so bear her down with its weight, it will past first a big mooring buoy. This buoy will bear up the weight of the chain, and in addition will contain a heavy coiled steel spring, which will give and take with the strains which the seas put upon the vessel, and make the whole cable elastic. Where the cable is made fast to the ship there will be another spring rider which will have six feet play, adding to the elastic nature of the mooring. The vessel will be provided, moreover, with a 100-fathom hawser, 12 inches in circumference, which her crew will bend on and over the end of the mooring cable in very bad weather. It will take a pull of 85,000 pounds to break this hawser. Riding at the end of the 300-fathom lines, away from the mooring anchor, and with the elasticity of the hempen hawser added to the spring arrangements already mentioned, it is believed a lightship will be able to weather all sorts of storms without damage to herself and without breaking away from her moorings.—New York Sun.

Personals

Mr. Murat Masterson has been elected Vice-President of the Raleigh & Western Railway.

Mr. M. H. Dooly was on March 4 appointed Receiver of the Gainesville, Jefferson & Southern.

Gen. J. G. Mann is President of the Tennessee Midland Railway Company, vice J. C. Clark, resigned.

Gen. George J. Magee, President of the Fall Brook Railroad, died at Nice, France, on March 11.

Mr. Thomas R. Brown, one of the Receivers of the old Seattle, Lake Shore & Eastern, died on Feb. 2.

Mr. J. K. P. Hall has been elected Vice-President and Secretary of the Buffalo, St. Mary's & Southwestern.

Mr. S. A. Sheppard, Master Mechanic of the Carrabelle, Tallahassee & Georgia, died at Lanark, Fla., March 14.

Mr. D. Hickey has been appointed Division Master Mechanic of the Union Pacific road, with headquarters at Evanston, Wyo.

Mr. H. D. Buaghardt has been appointed Purchasing Agent of the Minnesota & Wisconsin Railway, with office at Spring Valley, Wis.

Mr. C. B. McVay has been appointed Purchasing Agent of the Toleda, St. Louis & Kansas City, with headquarters at Toledo, O.

Mr. C. A. Gould, President of the Gould Coupler Company, sailed on the *St. Paul*, March 24, for a trip of several months in Europe.

Robert Patterson has been appointed Master Mechanic of the Florence & Cripple Creek Railroad with headquarters at Florence, Col.

Mr. G. A. Croft has been chosen Vice-President and Contracting Agent of the Wadley & Mount Vernon, with headquarters at Atlanta, Ga.

Mr. Nicholas Monsarrat, Vice-President of the Columbus, Hocking Valley & Toledo, was on Feb. 25 appointed Receiver of that road.

Mr. John Gill has been appointed Master Mechanic of the Illinois Division of the Chicago, Rock Island & Pacific, with headquarters at Chicago.

Mr. W. G. Taber, Master Mechanic of the Dunkirk, Allegheny Valley & Pittsburgh, died suddenly at Dunkirk, N. Y., Feb. 18, of heart disease.

Mr. B. F. Porter, Roadmaster of the Maricopa & Phœnix and Salt River Valley, will also have charge of shops and car repairs, vice T. J. Morrison, resigned.

Mr. Darius Miller has been appointed Vice-President of the Missouri, Kansas & Texas Railroad Company, in general charge of the traffic departments.

Mr. E. B. Thompson, for some time past Mechanical Engineer on the Chicago & Northwestern, has gone to the Northern Pacific in the same capacity.

Mr. F. H. McGee has been appointed Master Mechanic of the Georgia & Alabama, with headquarters at Americus, Ga., vice Mr. J. E. Worswick, resigned.

Mr. C. O. Johnson, who has had charge of all departments of the Pacific Coast Railway at San Luis Obispo, Cal., with the title of Superintendent, has resigned.

Mr. Russell Harding has been appointed General Superintendent of the Great Northern, with headquarters at St. Paul, in place of Mr. J. M. Barr, resigned.

Mr. William Grierson has resigned the position of Master Car Builder of the Dominion Atlantic Railway at Kentville, N. S., and has retired from railroad service.

Mr. Joseph Spragge has been appointed Master Mechanic on the Atlantic Division of the Canadian Pacific Railway, with headquarters at McAdam Junction, N. B.

Mr. W. A. Mills, General Manager of the Columbus, Hocking Valley & Toleda, has been appointed Traffic Manager of that road, and the office of General Manager is abolished.

Mr. James M. Barr has resigned as General Superintendent of the Great Northern and accepted the position of Vice-President of the Norfolk & Western, with headquarters at Roanoke, Va.

Mr. E. B. Gilbert, formerly on the Pittsburgh, Shenango & Lake Erie, has been appointed Master Mechanic of the new Pittsburgh, Bessemer & Lake Erie Railroad, with office at Greenville, Pa.

Mr. W. T. Gorrell, Assistant Master Car Builder of the Philadelphia & Reading, has been appointed Master Car Builder of that road, with headquarters at Reading, Pa., to succeed Mr. J. H. Rankin, promoted.

Mr. J. U. Jackson, President and General Manager of the Augusta Southern, has been appointed Assistant to the General Manager of the South Carolina & Georgia, which road has leased the Augusta Southern.

Mr. F. M. Leader has resigned as Ceneral Manager of the Bloomsburg & Sullivan, and the office is abolished. Mr. D. W. Campbell has been appointed General Superintendent, with headquarters at Bloomsburg, Pa.

Mr. William Sinnott, who has been Division Master Mechanic of the Baltimore & Ohio Railroad Company at Cumberland, has been transferred to Philadelphia. Mr. Courtney, of Grafton, W. Va., succeeds Mr. Sinnott at Cumberland.

Mr. W. G. Nevin, at present General Purchasing Agent of the Atchison, Topeka & Santa Fe, will, it is understood, succeed the late K. H. Wade as General Manager of the Southern California Railway, with headquarters at Los Angeles, Cal.

Mr. James D. Livingston has resigned as Vice-President and General Manager of the Lexington & Eastern, and Mr. A. W. Barr has been appointed General Manager and Mr. George Copland Vice-President, with headquarters at Lexington, Ky.

At a meeting of the Trustees of the Schenectady Locomotive Works, held March 6, Mr. William D. Ellis was elected President, in place of Edward Ellis, deceased; Mr. Albert J. Pitkin, Vice-President and General Manager; and Mr. A. M. White, Superintendent.

Mr. S. F. Parrott, recently General Manager of the Columbus Southern, has been chosen Vice-President and General Manager of the Gulf City Construction Company, which concern is building the Mobile, Jackson & Kansas City road. Headquarters, Mobile, Ala.

Mr. C. M. Higginson, who about a year ago was made Assistant to the President of the Atchison, Topeka & Santa Fe, has accepted the position of Purchasing Agent for the system, left vacant by the appointment of Mr. W. G. Nevin as General Manager of the California lines of the company.

The offices of General Superintendent, Chief Engineer, Superintendent of Motive Power, General Road Master, and Superintendent of Bridges and Buildings of the Alabama Great Southern Railroad have been abolished, and the control of the departments placed in the hands of Superintendent Wickersham, who will, as heretofore, report to Mr. Vaughan, Assistant General Superintendent, at Chattanooga.

Mr. Kirtland H. Wade, General Manager of the Southern California Railway, died suddenly at Los Angeles, Cal., March 11. Mr. Wade entered railway work at the age of 14 years as a telegraph operator, and advanced until, in 1870, he was Master of Trains of the Illinois Division of the Wabash. Later he became Superintendent of the Ohio & Indiana Division. In 1881 he went to the C., B. & Q. R. R., but returned to the Wabash in 1882 as Superintendent of Transportation. In November, 1889, he accepted the general management of the Southern California.

Mr. Edward Ellis, President of the Schenectady Locomotive Works, died at his home in Schenectady on the night of Feb. 27, at the age of 53 years. The company of which he was President was organized in 1848 as the Schenectady Locomotive Engine Company. In 1850 the works were purchased by John Ellis, D. D. Campbell and Simon Groot. The following year the Schenectady Locomotive Works were incorporated, and by 1863 Mr. John Ellis had acquired nearly all the stock. He was President until his death, Oct. 4, 1864, and since then the position has been held successively by three of his sons, Mr. Edward Ellis becoming President in 1891.

Mr. Thomas Seabrook, who was for years prominent in the engineering department of the Pennsylvania Railroad, died in Philadelphia on Feb. 24, in his 80th year. His first service in the employment of the company was as an engineer in locating the line through the western part of Pennsylvania. Later he was stationed at Gallitzin, in charge of construction work. In 1854 he was appointed Assistant Superintendent of the Western Division and in 1857 was appointed Resident Engineer in charge of the road between Harrisburg and Pittsburgh. In 1859 he became Chief Engineer of the Western Transportation Company, in charge of the survey and construction of lines west of Pittsburgh, now a part of the Panhandle route. His last important railroad work was the building of the eastern end of the West Shore Railroad.

The passenger department of the Mobile & Ohio Railroad recently sent out something unique in the way of railway advertising flyers or bills. It is a deep-blue banner or hanger about three inches wide and 20 inches long, and in red and white letters conveys the information that three premiums for fruits, grains and grasses, given at expositions, are positive proof of the richness of the lands along the line of the M. & O. R. R. A list follows of the cheap excursions which the road will give to the lands still for sale, which aggregate 500,000 acres. The novelty of these bills has caused such a demand for them that 350,000 have been sent out, and General Passenger Agent Mr. E. E. Posey says the inquiries for them are more numerous than ever.

The Friction of Piston Valves.

At the 1896 convention of the Master Mechanics' Association, a committee reported on slide valves and gave the results of elaborate tests on the friction of slide valves, balanced and unbalanced. The Chicago, Burlington & Quincy Railroad has since that time applied the same apparatus to the piston valves of its engine No. 498, with the result given in the accompanying table. The methods employed were the same as those used by the committee, and the results are comparable to some extent. In looking up the figures given in the report alluded to we find that most of them were conducted with a very low steam chest pressure and this is one of the barriers to a comparison of results. Probably no two persons would make the same selections from the mass of figures on plain and balanced slide valves given in the report for comparison with the figures here given, but in order to give our readers an idea of the relative frictions we have ventured to compile table No. 2. It will be seen that the figures are somewhat erratic, but in general the percentage of power consumed by the piston valve is much less than that of the balanced valves. In the third group of the table, including lines 9 to 15, the higher speeds and pressures for the piston valve tests need to be borne in mind. Making allowance for these differences the average indicated horse-power of the valve cards is even then somewhat greater than in the single trial of a balanced valve with which it is compared, though on the basis of the percentage of power absorbed the showing is in favor of the piston valve.

TABLE NO. 1.—SHOWING FRICTION OF PISTON VALVES IN ENGINE 498, C., B. & Q. R. R., TESTED JULY 31, 1896.

Rev.	Steam chest pres.	Cylinder card.			Valve card.						S. C. press. by 4.81.†	I. H. P. valve cards.	Per cent. of I. H. P. of cyl.
					Length	M. E. P.							
		Cut-off	Ave. M.E.P.	I. H. P.		Front.	Back.	Ave.	Diff.	Diff. by 7.07.*			
75	100	18 in.	81.4	210	3.14	85.8	28	56.9	57.8	409	481	.48	.24
81	145	14 "	108.6	303	2.46	110.6	7.8	59.2	102.8	717	697	.42	.14
109	130	14 "	93.1	353	2.34	117.9	5.1	61.5	112.8	798	625	.56	.16
109	140	9 "	65.6	246	2.03	98.9	16.1	57.5	82.8	575	673	.45	.18
163	145	7 "	40.8	230	2.02	139.4	38.8	89.1	100.6	721	697	1.05	.46
190	145	7 "	37	243	2.14	157.2	45.4	106.2	111.8	790	697	1.4	.69
65	80	18 "	71.3	159	2.97	78.8	28.8	53.8	50	353	385	.37	.22
109	90	18 "	70.5	264	3.10	25	12.7	18.9	12.3	90	433	.33	.08
163	117	14 "	64.8	263	2.72	108.2	16.4	62.4	91.8	649	562	.99	.28
54	145	14 "	117.6	279	2.42	84.9	14.2	49.6	70.7	500	697	.23	.11
163	150	9 "	47.1	261	2.16	131	12.1	71.6	118.9	840	722	.9	.34
Averages				260						576	606	.61	.25

* 7.07 = Area of dynamometer piston.
† 4.81 = 2 by area of valve stem.

TABLE NO. 2.—COMPARISON OF UNBALANCED AND BALANCED SLIDE VALVES WITH PISTON VALVES.

Line.	Kind of valve.	Speed. (Rev.)	Steam chest pres. lbs.	I. H. P. of valve cards.	Per cent. of cyl. power consumed by valve.
1	Unbalanced slide	212	130	3.19	1.62
2	Balanced slide	212	129	1.38	0.62
3	Piston	190	145	1.40	0.60
4	Unbalanced slide	106	106	1.28	....
5	Balanced slide	106	103	0.53	0.45
6	Piston	109	135	0.50	0.17
7	"	109	90	0.33	0.08
8	" (average of 6 and 7)	108	113	0.42	0.13
9	Unbalanced slide	53	93	0.55	0.12
10	Balanced slide	53	90	0.19	0.37
11	Piston	65	80	0.37	0.22
12	"	51	145	0.23	0.11
13	"	75	100	0.48	0.24
14	"	81	145	0.42	0.14
15	" (average lines 11, 12, 13, 14)	69	117	0.37	0.18

We give the figures in Table No. 2 as the fairest comparison that we can make with individual tests. Taking these tests and the M. M. committee tests in their entirety we find the average power consumed by the piston valve to be .25 per cent. of the cylinder power, while the best balanced valves in the M. M. committee tests averaged .51 per cent., showing the piston valves to consume about one-half as much power as the latter.

It is interesting in this connection to note that the difficulties encountered in times past by those who tried to use piston valves appear to be overcome. The most serious of these troubles arose from the earlier piston valves being altogether too small for the work. At present the tendency to use piston valves for simple locomotives using high steam pressures is quite marked and we should not be surprised to see them quite generally introduced in the near future.

A Seven-Foot Boring and Turning Mill with a Slotting Attachment.

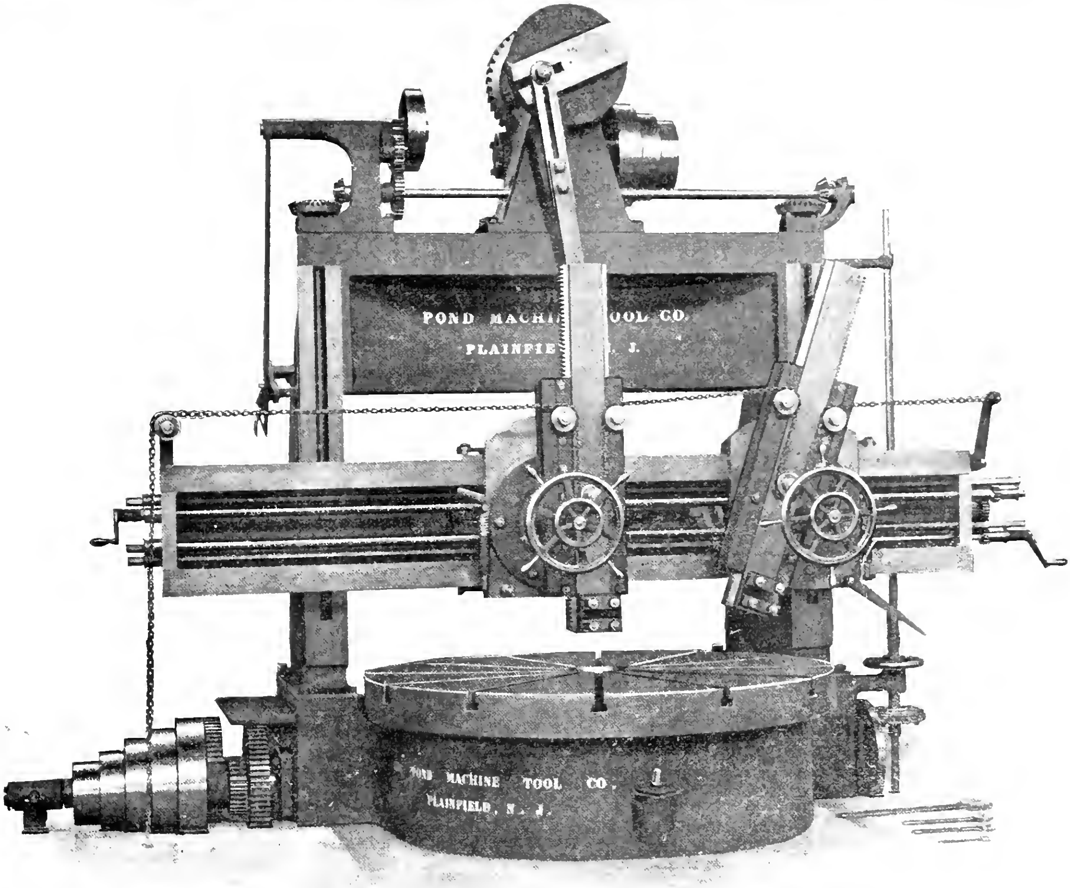
We illustrate herewith an excellent and powerful tool built by the Pond Machine Tool Company, Plainfield, N. J. It is a seven-foot boring and turning mill, to which is fitted a slotting attachment, thus giving the tool a wide range of utility.

The mill will take in work 85 inches in diameter and 48 inches high. The face plate is 78 inches in diameter and has a very wide bearing on the bed, nearly equal to the diameter of the plate, and is mounted on a spindle having large bearings adjustable for wear, and with sufficient length to avoid any possibility of the face plate tipping when the tools are taking heavy cuts in their highest position. The lower bearing of the spindle is mounted on a step resting on a wedge which can be adjusted so as to lift the plate off its bearing on the bed when it is required to revolve at high speed or moved by hand when setting and fastening work. This wedge is adjusted from above the floor, thus making it convenient for the operator. The table has 10 changes of speed, and is driven by a cone of large diameter with wide steps for the belt, and geared to an internal gear.

The tool-slides, saddles and crossrail are all made very strong, and are provided with large bearing surfaces. The tool-slides have a traverse of 48 inches and are counterbalanced. Their large flat wearing surfaces fit the entire length of the swivels, making the strongest possible support. The tool holders are of the favorite form, consisting of two straps and four bolts, permitting the use of ordinary lathe or planer tools. The swivels are set at any desired angle by means of a worm and ratchet mechanism. The crossrail has large wearing surfaces and is elevated by power. The saddles are attached to steel feed-screws by nuts, which can be quickly opened, and a rapid movement of the saddles obtained by means of a ratchet and a pinion engaging a steel rack on the crossrail. The feeds of the two tools are independent of each other and can be instantly changed from zero to the maximum. The feeds are operated by a friction wheel, the parts being so proportioned as to give ample power under all conditions.

When so desired this tool can be used for turning pulleys on an arbor, and for this work there can be furnished an equalizing drive-plate, a saddle on the crossrail fitted with a spindle similar to the tail spindle of a lathe, and a center fitted to the face-plate.

The slotting arrangement is carried on a pedestal mounted on the top of the arch and fastened to it by means of bolts in T slots, permitting it to be placed in line with the tool-slide when the latter is located over the work. It consists of a worm-driven crank disk slotted for a pin adjustable from 6½ inches to 18 inches stroke. It will be noticed from our engraving that the connection to the tool-slide is slotted: this is for the purpose of adjusting the stroke to the location of the slot to be cut. The slotting attachment has three speeds. The cone on the countershaft can be adjusted to any position along the shaft to suit the location of



Seven-Foot Boring and Turning Mill With Slotting Attachment.—Pond Machine Tool Company.

the cone on the pedestal when the slotting arrangement is in position for work.

Excellent workmanship and substantial design, combined with the greatest possible convenience to the operator, serve to make this tool all that can be desired, and its special features give it a wider range of usefulness than is ordinarily attained. It is placed on the market by the well-known firm of Manning, Maxwell & Moore, 111 and 113 Liberty street, New York City.

Lincoln's Car.

In an obscure corner of the yards of the Union Pacific car shops in Omaha, in a delapitated and abandoned condition stands a truly historic relic known as the "Lincoln car." Its sides are cracked and weather-beaten, and the glass in its windows and the brass railings on its platforms are long ago gone. All the compartments and sumptuous interior furnishings and decorations have been removed, and it stands like a barren, decaying hulk of its once proud self. From its former prominent association with President Lincoln, both during the later years of his life and then after his death, it would seem the car deserves a better fate than to rot in neglect and obscurity. This car was built especially for Mr. Lincoln in the United States military car shops at Alexandria, Va., in 1864, by B. P. Lamason, Master Car Builder, and was certainly one of the handsomest private railway coaches in its day. It was used by the President repeatedly in his visits to the army of the Potomac down in Virginia, and also to New York and Philadelphia.

The Lincoln car is 42 feet long by 8½ feet wide, and during the time Mr. Lincoln used it was divided into three compartments. It was entered by a door which opened into a narrow passageway extending the entire length of the car along one side.

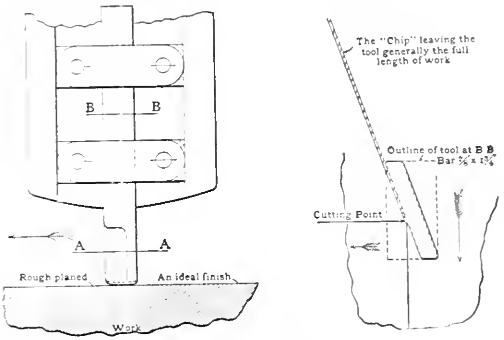
From this passageway doors opened into each one of the three private rooms. The room in one end of the car was considerably larger than the others, and was furnished with a large sofa and reclining chairs, although somewhat inferior to those in the large room. This larger compartment constituted President Lincoln's office and study, and was where he entertained his guests and transacted business with officials of the government and generals of the army. The sofa is a combination affair and was made of unusual length to accommodate the elongated form of the President: It was used as a sofa or lounge during the day and at night could be adjusted into a double bed.

The car was considered in that day a triumph of the car builder's art. The walls of each of the compartments were padded with rich corded crimson silk upholstery, extending half way to the ceiling, and the freize of the President's room was decorated with painted panels of the coat of arms of the different States of the Union. The car was ironclad, armor being set in between the inner and outer walls, rendering it bullet proof. This added considerable to its weight, so much so that its buildets thought it necessary to mount it on four four-wheeled trucks.

This famous old car will form the central figure of the transportation exhibit at the Trans-Mississippi and International Exposition of 1898, at Omaha.

Planer Finishing Tools.

In a letter to the American Machinist Mr. Wm. Pilton, of Hamilton, O., describes a planer finishing tool as follows, the cut referred to being reproduced from the pages of our contemporary: "The accompanying drawing will make clear to the reader this finishing tool and its helical rolled chip of steel or wrought iron. I first saw it in use at the Niles Tool Works, and learned that it was arrived at after several experiments made, a few years ago by the planer foreman, who has received many inquiries for a sketch. Its cutting action is perfect, as shown by chips from heavy and light finishing cuts. It works well without the



Planer Finishing Tools.

aid of a lubricator or cutting solution, solving the problem of finishing such difficult metals—usually very trying to a planer hand.

"It may be well to add that at the same works they have these tools for use on planer tables and similar large surfaces, having a cutting face of three inches, giving a very wide finishing cut, and a chip that rolls itself 'spirally' several turns. A sample generally finds its way to the tool chest as a curiosity and to give support to the story. Those who have been accustomed to fine machine feed finish have looked with surprise on the ½ to a 2 crank-turn finish feed.

"Wide-face Mushet steel tools are used in reducing to size between the one roughing and the final finishing cut; and for this last a tool is used which has received almost the care of a razor in its preparation for the work."

Association Scholarships.

The Secretary of the Master Mechanics' Association announces that there will be two vacancies in the association scholarships at the Stevens Institute of Technology, at the close of the present college year in June. Sons of members of the association who are eligible for these scholarships, and who desire to attend the preliminary examinations, should apply to the Secretary, and, if found eligible, he will give a certificate to that effect for presentation to the school authorities, which will entitle the candidate to attend the preliminary examinations. These examinations will begin at the Institute on June 4 and continue until June 10. When it is desired, the school authorities will arrange for the examination of an applicant at any of the large cities of the country, but in that case the applicant must pay the Institute a fee of $10, to cover the additional cost of conducting the examination there.

The Progress in the Manufacture of Iron and Steel in America and the Relation of the Engineer to It.*

BY JOHN FRITZ, BETHLEHEM, PA.

(Continued from page 62.)

The subject of hollow forging being one in which the mechanical engineer is more or less interested, I will give a brief description of the process, and how the ingot is prepared. Having already told you that the metal is subjected to pressure while in a fluid condition, I will commence with a cold ingot. It is first examined externally, and if there are no imperfections visible it is then put into a powerful lathe, and after the proper discard is cut off it is then cut to the proper length, that being determined by the final weight of the forging it is intended for. Next it goes to the boring mill, and is bored out to a size corresponding to the diameter of the hole in the finished forging. You now have the ingot (or such part as you want) in the best possible shape for examination; and this is not all, for the center of the ingot is always the most undesirable part of it, and the boring of the hole gets it out of the way entirely. We now have it in the most desirable condition possible for the heating furnace, where it next goes, and it is in the heating that it is exposed to its greatest danger, and where skill and the greatest possible care are required, and it must be charged in a cold furnace, which should be a preheating furnace, and heated up slowly until the heat reaches the center; it is then taken to the forge furnace, and heated slowly and regularly (in order to prevent internal strains), until it reaches the proper temperature for forging. The higher the carbon the more care is required, especially in the first heating, it being the crucial test and the time when the damage is generally done; if once done, it cannot possibly be repaired. When it is finally brought up to the proper heat it is taken to the press, and a mandrel is put in, and the forging commenced, and this part of the operation requires skill, sound judgment and great care to see that it is worked at the proper heat, and in a manner that will not produce any undue internal strains, and in irregular forgings special car must be taken in shouldering down and in working up flanges or projections, in order to prevent "fins," or excrescences, from forming, that may unnoticed work into the body of the forging. One of the great advantages of hollow forgings over solid is that by boring out the center of the ingot the metal is reduced to less than one-half the thickness of the solid forging, and by using the press, the action being slow, the ends of the forging are convex, showing that the force of the press had reached the center of the metal, while the hammer strikes a quick and sharp blow, affecting the outside of the metal to a much greater extent than the inside or center, consequently the end of the forging is concaved, showing at once the superiority of the press over the hammer. There are other advantages in the use of the press for forging purposes, but time will not permit a proper description of them.

The first shafting made was in 1888. The tensile strength of the steel was about 60,000 pounds, and elongation about 28 or 30 per cent, in two inches. At that time but little attention was given to the elastic limit or the contraction of area, which is now considered important, especially the latter.

Test bars taken from a certain puddled bar reworked car axle varied between 44,000 and 45,000 pounds, the elastic limit between 18,000 and 23,000 pounds, the elongation between 21 and 27 per cent., the contraction of area between 40 and 48 per cent.; compare this with some results obtained in hollow-forged, oil-hardening, and annealed nickel-steel shafting, the physical properties of which are: tensile strength, 95,000 to 100,000 pounds; elastic limit, 60,000 to 65,000 pounds; elengation, 20 to 25 per cent.; contraction of area, 55 to 60 per cent. It is safe to assume that in shafts of any size a nickel-steel shaft as above would have three times the elastic strength of a wrought-iron shaft, and taking into consideration the fact of hollow forging with judicious proportioning of inside and outside diameter, it would be possible to make a nickel-steel shaft of one-quarter the weight of a wrought-iron shaft and obtain the same elastic or working strength. The greater contraction of area shown by the nickel steel proves it a safer material against shock, as the greater the contraction the greater will be the amount of local distortion that can take place without rupture. This is clearly shown by the old but still reliable bending test, which is always in proportion to the contraction of area, and not to the elongation, as most commonly supposed. This

* From the President's address before the Amer. Soc. of Mech. Engineers.

nickel-steel test is no fancy one gotton up for show, but was taken from the forging, and was the test the work was actually accepted on, and was taken from a prolongation of the forging of a shaft 17 inches diameter, with the hole 11 inches diameter. The shaft which this test was taken from was specially treated by oil-hardening and annealing. While I am fully aware that there are many persons, and some of them high in authority, that doubt the propriety of such treatment, yet when the work is in a proper shape to receive the treatment, and it is made with intelligence and care, my experience has fully convinced me that this special treatment produces the best possible results, and for many purposes it is indispensable. Steel can be made higher in tensile strength and elastic limit than the test referred to, but to some extent it will be at the expense of extension and contraction of area.

I have already said that it was not the object of this paper to give any definite instructions as to the kind of steel to be used for various purposes, yet a few remarks showing how very difficult it would be to do so may prove both interesting and instructive. Forgings are made from grades varying from .10 carbon to 1.00, according to the purpose for which they are to be used.

The physical properties, as shown by test bars, will vary with the carbon, the size of forging, the amount of work put upon it; that is, two similar forgings made from different sized ingots will give different results. The treatment after forging, such as annealing, oil-hardening, etc., where varying temperatures produce widely varying results, with all these conditions to be considered, it is quite impossible to give definite figures unless the conditions are well known. Take for instance two forgings of considerable difference in size and shape, both of which must show about the following properties:

Tensile.	Elastic limit.	Elongation.	Contraction of area.
80,000	45,000	15	50%

One may require a steel of .30 carbon and the other .45 carbon. These two steels, if rolled down to small bars, would show about the following results:

Carbon.	Tensile strength.	Elastic limit.	Elongation.	Contraction of area.
30	85,000	50,000	22	55 per cent.
45	95,000	60,000	18	50 "

Under ordinary conditions the elastic limit is about 50 per cent. of the tensile strength. In order to increase this proportion special treatment of the forging is resorted to. The elongation and contraction of area are also increased by treatment, especially the latter, so that with the elastic limit and coutraction we have a safe index as to the condition of the metal, and as these two properties vary much less with the length and diameter of test bar, they are more valuable in comparing results from varying sizes of test bar. As the carbon in steal increases, the variation, due to work reduction, becomes less, while that of annealing becomes greater. The variation obtained by treatment increases rapidly with increasing carbon.

Steel .45 in carbon showing:

Tensile Strength.	Elastic Limit.	Elongation.	Contraction of Area.
90,000	45,000	15	40%
By oil-tempering:			
96,000	55,000	18	50%

The above are about the best figures to be used in forging ordinary work. If higher or lower strength is required, it may be obtained by varying the carbon. If increased strength and elastic limit are required, without sacrificing toughness, it may be obtained by using nickel steel.

In conclusion, the modern practice of steel making has, in the hands of the mechanical engineer, the metallurgist, and chemist, wrought wonders in producing a material which in quantity, physical qualities, and cheapness would have been regarded as utterly impossible half a century ago, when steel rails, beams, angles and plates were not thought of. The labors of the men of iron and steel have so cheapened their products that to-day we are enabled to use steel for the commonest purposes as well as for the most expensive articles produced by the skill of the mechanic. No article is too humble to be made of it, and no structure so grand and important as to refuse its services; it is demanded in the frying-pan as well as in the vast bridges and viaducts, as well in the housewife's needle as in the great leviathans that have made the ocean but a span of less than a week; thus we find steel asserting its value through every walk of life, and extending to every clime, linking lands in that bond which grows broader and stronger with the years, till even now we can see, if but dimly, on the horizon the promise of the linking of nations in the universal brotherhood of mankind, and bringing the longed-for era of eternal peace.

Ruling of the Arbitration Committee—Responsibility of Intermediate Roads Handling Cars Improperly Repaired, but Not Carded.

From the report of the decisions of the Arbitration Committee of the Master Car Builders' Association rendered at meetings held in December, 1896, and January, 1897, we publish Case No. 394 which is important as fixing the responsibility of intermediate roads handling foreign cars on which improper repairs have been made, but not carded for. On Sept. 3, 1896, the Chicago, Rock Island & Pacific Railway received its car 31,056 from the Lake Shore & Michigan Southern Railway in Chicago. At that time the C., R. I. & P. inspector noted a wrong drawbar, two lug castings and wrong draft timbers. A demand was made on the L. S. & M. S. inspector, and L. S. & M. S. card was isued on Oct. 6, calling for "one wrong malleable pocket drawbar 27 inches in place of 24 inches long," and the inspector refused to give card for the wrong draft timbers and wrong lug castings, claiming that while the car was in the possession of the L. S. & M. S. Railway it made no repairs to these items. The C., R. I. & P. Railway then took the matter up on these facts, by correspondence with the L. S. & M. S. Railway, and the latter argues that the new Rules of Interchange clearly indicate in the preamble that car owners are responsible for repairs of damage other than that caused by unfair usage, and that where cars are damaged by unfair usage the company damaging the car must make proper repairs or card the car covering such damage; it calls attention to the fact that Section 49 of Rule 3 states that a company making improper repairs is solely responsible to the owners, with certain exceptions which are named; also, that Section 15, Rule 4, says that a company repairing cars with wrong material and not in compliance with the Sections of Rule 4, shall be liable to the owners for the cost of changing to the requirements of the rule; that Section 5 of Rule 5 states that when the repairs have not been properly made the owners may bill against the company making the wrong repairs for the cost of changing the car to the requirements of Rule 4. It claims that the rules thus clearly indicate that the settlement of responsibility for wrong repairs is between the owners and the company making the wrong repairs, and it does not find any reference, either direct or indirect, in the rules to the effect that an intermediate company is responsible for the wrong repairs made by another company.

The C., R. I. & P. Railway Company claims that the L. S. & M. S. Railway Company admitted responsibity by issuing card for the wrong drawbar, as it is fair to assume that the wrong drawbar was applied at the same time the two wrong-framed draft timbers and the two foreign lug castings were applied; that these items break the combination and make it a case of rough handling; it quotes Rule I of the M. C. B. code, which says: "Each railway company shall give to foreign cars while on its line the same care as to oiling, packing and inspection that it gives to its own cars," and it argues from this that the L. S. & M. S. Railway Company has not complied with the rules, as if it had not damaged this car and made wrong repairs it should have protected the C., R. I. & P. Railway the same as it would have protected the L. S. & M. S. Railway in the case a of L. S. & M. S. Railway car being offered home with similar wrong repairs. It says that if this car was received on the L. S. & M. S. Railway and Section 49 of Rule 3 had not been complied with, it was the duty of the L. S. & M. S. Railway to protect itself and thereby protect the owner; that if the intermediate line handling the car last is not made responsible in some way there is nothing to prevent foreign lines, after having damaged a car, from sending it home and the owner being unable to place the responsibility.

To this the Lake Shore replies that it received the car from the Pennsylvania Railroad at Erie nine days prior to date of its delivery to the Rock Island and that no repairs were made to the car while in its possession. That its reason for issuing the defect card for wrong drawbar was to comply with Section 46 of Rule 3, which makes the delivering road responsible for improperly fitting drawbars, and that the owners claimed it was three inches too long.

Failing to settle the matter, it is referred to the Arbitration Committee, by mutual consent, for decision. The committee decided as follows:

This question involves the responsibility of an intermediate railroad for wrong repairs which it did not make. Under the rules which went into effect Sept. 1, 1896, Section 49 of Rule 3 states that the company making wrong repairs is solely responsible to the owners, with certain exceptions noted, but the rule also provides that the company making the repairs shall apply a repair card, and,

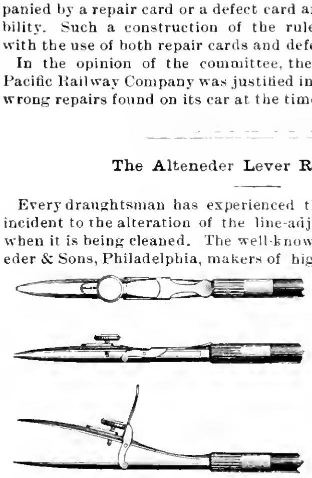
if improper repairs are made, accompany the repair card with a defect card. The second paragraph of the preface says: "Railroad companies handling cars are responsible for damage done to any car by unfair usage, derailment, accident, *or improper repairs*, and they should make proper repairs at their own expense, or *issue defect card* covering *all such damage*." The inference from Rule 1 and from the last paragraph of Section 1, Rule 3, is that a car-owner's interest is protected by intermediate lines giving such cars the same attention and inspection that they would their own cars. Where Section 49, Rule 3, says, "Solely responsible to the owners," it means that it is not responsible to anybody else for improper repairs *under the rules*, but the rules do not say that if a railroad company fails to comply *with the provisions of the rules* for locating responsibility, that the intermediate road may also escape responsibility by simply stating that it did not make the repairs. To escape responsibility it must see that either a repair card or a defect card is carried, or must itself furnish a defect card for the wrong repairs. Any other construction of the rules would be encouraging any kind of repairs to owner's cars and would be offering the strongest inducements to railroad companies to evade the use of repair cards as well as defect cards, which form an essential part of the rules and are expressly provided for in Rule 4, Section 16, and Rule 3, Section 1.

It is argued that a discussion was had at the last convention on this very point, and that a motion to amend the last paragraph of Section 1, Rule 3, by adding after the word "Responsible," the words, "Or improper repairs covered by a repair card," was voted down, and therefore it was evidently not the intention of the association to demand responsibility in the way of inspection by intermediate roads in such cases. This argument would stand in this case if the car had carried a repair card, covering repairs to these parts. The joint-evidence statement of the Rock Island and Lake Shore roads as to the condition of the repairs would have been sufficient to warrant collecting from the parties making the repairs, who would be located through their cards. The Arbitration Committee has an intimation from the discussion above referred to as to what the association thought when a car having wrong repairs carried a repair card, and no defect card, but it has no intimation of what course the association would think best if neither a repair card nor defect card is attached to the car, except by inference from the rules themselves. The Arbitration Committee cannot believe that the association contemplates ignoring the rights of car owners in the way that would inevitably follow should they rule that cars may be received by intermediate railroads with evident wrong repairs and without being accompanied by a repair card or a defect card and not incur any responsibility. Such a construction of the rules would quickly do away with the use of both repair cards and defect cards.

In the opinion of the committee, the Chicago, Rock Island & Pacific Railway Company was justified in demanding a card for the wrong repairs found on its car at the time of inspection.

The Alteneder Lever Ruling Pen.

Every draughtsman has experienced the annoyance and delay incident to the alteration of the line-adjustment of a ruling pen when it is being cleaned. The well-known firm of Theodore Alteneder & Sons, Philadelphia, makers of high-grade drawing instruments, have recently brought out an ingenious pen in which that difficulty is overcome. It is shown in the accompanying engraving. The pen is made in one piece, with the upper blade in the form of a spring, the action of which is such as to constantly press the points together. The adjusting-screw is fitted to the upper instead of the lower blade (as is usual), and merely bears against the inner surface of the latter, thus separating the points to obtain the desired width of line. A lever having parallel arms is pivoted to the lower blade, and is provided with a bar connecting the two arms and located between the blades. When the lever is lifted, the bar raises the upper blade and holds the points apart for cleaning. After the pen is cleaned the lever is pushed down and the points assume their former relation to each other, the adjusting screw having remained untouched. Not only is the adjustment undisturbed, but the cleaning is easily and rapidly done. A five or five and one-half inch lever pen with ebony handle is listed at $2.50. They are also furnished with aluminum or ivory handles if desired. The address of the makers is 945 Ridge Avenue, Philadelphia, Pa.



Apparatus for the Combustion of Powdered Coal.

Some time ago we illustrated an apparatus for burning coal in which the blast performed several functions besides that of actually carrying the powdered fuel to the firebox. Herewith we reproduce from our contemporary Engineering the engravings of the Ruhl apparatus, the distinctive feature of which is that the conveying and the feeding mechanism are combined, avoiding the need of any further apparatus. Further, by providing for two worm conveyors acting in opposite directions, the storage chamber has been dispensed with. The draft has to carry the dust through a short distance only.

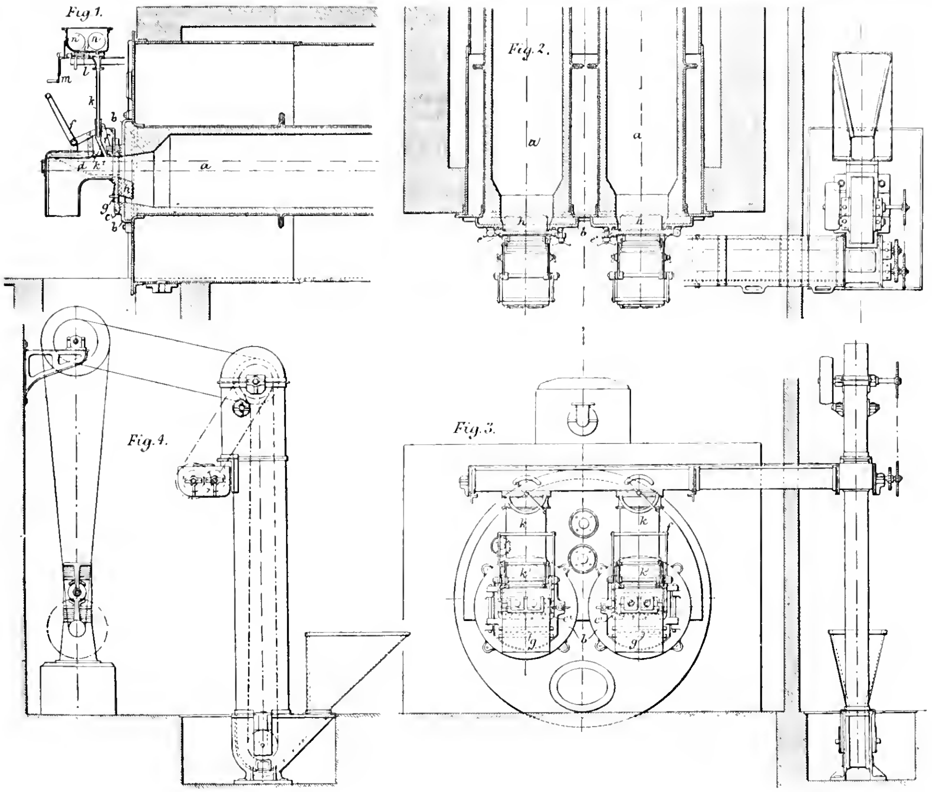
"The boiler which was fitted with this apparatus had a length of 8 meters (26 feet 3 inches), a diameter of 2 meters (6 feet 6 inches), and a heating surface of 58.8 square meters (633 square feet). It actuated two pulsometers supplying 6,000 and 7,000 liters (1,320 and 1,540 gallons) of water per minute for the fountains and cascades. The iron chimney, close to the boiler-house, had a height of 20 meters (65 feet), and a diameter of 0.6 meter (2 feet).

The two furnaces, 700 millimeters (27.6 inches) in diameter, were lined with firebrick over a length of 3 meters (10 feet). This space forms the furnace chamber a (see Figs. 1 and 2 annexed); there is no grate. The chamber is closed in front by a cast-iron frame b lined with firebrick on the inside, and the door c. This door supports by means of levers f (Fig. 3) an air shaft d of adjustable section; below this are a series of smaller openings, also adjustable, through which further air can be admitted; this latter air strikes against the block h, and is heated, while h itself is cooled. The movable cover of the air shaft d supports the shute k^1 which opens just in front of the furnace. The upper end of k^1 embraces the shute k, connected by means of the slide l, which can be set by the crank m, with the conveyor trough o. Two worms n and n^1 are placed in this trough; the second takes up the excess of fuel transported, and carries it back to the starting point, where the fresh fuel is being deposited. An elevator (Fig. 4), actuated together with the worms by an electric motor, takes up the fuel from a funnel shaped trough which feeds as much fuel as all the furnaces connected with the stoking appliance would require at maximum working. The height of the bridge separating the elevator shaft from the conveyor trough is such that this trough, filled up to that height, would satisfy the maximum demand. When not working at full power, or when one of the furnaces is disconnected, the conveyor worm throws back into the elevator shaft the excess of fuel over the normal charge which has been previously fixed. There can hence be no overcharging the conveyor trough, while a deficiency in fuel cannot arise either, as long as the elevator trough is properly attended to.

"The worm keeps the fuel in constant motion. When the coal slide whose projecting edges are scraped by the worm is open, the fuel glides at a constant rate down the shutes k, k^1 into the air shaft d. The slide l is set by means of the crank m; thus the feed is regulated according to requirements. The letters e and e^1 mark sight holes.

"In the space d the coal-dust and air mix. The velocity of the air current, which is to carry the dust into the furnace and not further, is regulated by means of the levers f which raise or lower the cover of the shaft. The quantity of air required for complete combustion is controlled by means of the damper.

"That this arrangement answers, and that only a slight amount of ashes containing little unconsumed coal is carried beyond the firebridge, is proved by the tests which were conducted at the Royal Opera of Berlin during the winter of 1895-6. At the end of the first three weeks, during which 19,900 kilograms of coal-dust were burned, 330.5 kilograms of ashes, *i. e.*, 1.63 per cent. of the material supplied, were found in the flues. At the end of the second period of nine weeks, during which 54,100 kilograms of coal were burned, 650 kilograms, or 1.2 per cent., of ashes were found. These ashes contained only 4.7 per cent. of coal. It was further ascertained by the government inspectors that the gases traveled through the flues with a velocity of 5 or 6 meters (from 16 feet to 20 feet) per second, and that they left the flues at a temperature of 275 degrees C. (527 degrees Fahr.).



The Ruhl Apparatus for the Combustion of Powdered Coal.

"A little wood is lighted to start the boilers. As soon as this is well in glow, the feed of coal-dust is commenced. The dust ignites instantaneously, and the firebricks soon become hot enough to maintain a brisk combustion. After an interruption of an hour or an hour and a half, a little paper or cotton waste will suffice to restart the flame. At intervals of about six hours the cinders have to be removed. For this purpose the coal-slide, the damper and the air shaft have to be closed, when the lower shute k will clear the upper shute k^1. The firedoor c can now be opened. The residue forming a liquid mobile slag, which cools quickly, the mass must at once be raked out, as otherwise it would coat the firebricks. The operation does not require more time than with ordinary grates, however.

"The double worm conveyor is not an indispensable part of this apparatus. Where there are coal bunkers on both sides of large boilers or other furnaces, as on board ship, one conveyor will suffice both for the transport and the feed. This conveyor has then to be supplied with a double gearing so as to act in either direction; the fuel not used will be carried over to the other bunker. The conveyors require about 0.01 horse-power per running meter. The attendance is the simplest imaginable, and the parts are strong enough to insure durability and reliable working."

The economy is given as 22 per cent., but it is not clearly stated whether this saving is in coal alone or includes the economy in labor. Mr. A. Bossig, of Berlin, is introducing the apparatus.

The Trans-Mississippi and International Exposition of 1898.

We learn that the applications for space at the Trans-Mississippi and International Exposition, to be held in Omaha next year, are pouring into headquarters, and that already many excellent and interesting exhibits are assured. Manager E. E. Bruce, of the department of exhibits, announces special prizes, consisting of six gold trophies, six silver cups and six gold medals, to competitors in each of the following classes; for the best display of an irrigation system in operation; for the best electric light service in display; for the best display illustrating the process of manufacture of beet root sugar; for the best display of a manufacturing plant in operation; as well as two more lots of similar prizes for other high-class exhibits to be designated hereafter.

The Chicago & Northwestern Railway has just announced a subscription of $30,000 to the stock of the Exposition. The Burlington road has subscribed $30,000; the Rock Island and Union Pacific will each subscribe $25,000; the Missouri Pacific $20,000, and the Milwaukee $20,000. The total stock subscriptions now amount to $438,480, and the promised subscriptions of the railways will raise the total to $528,480. Z. T. Lindsey, manager of the department of ways and means, expects to secure at least $1,000,000 in stock subscriptions.

Congress has appropriated $200,000 to defray the expenses of a national exhibit. The government will erect a great building for its exhibit.

The State of Nebraska will appropriate $200,000, while Omaha and Douglas County will vote bonds in the sum of $200,000 in aid of the Exposition. California will appropriate $50,000. Iowa has appropriated $10,000 and will increase the amount later. Appropriation bills are pending in most of the legislatures in States and Territories west of the Mississippi River.

The exposition site in the northern suburbs of Omaha embraces ample area, is most accessible and in every way adapted for the purpose. The Board of Managers passed a resolution providing for the following nine buildings, which will constitute the nucleus around which the smaller buildings will be assembled:

Building No. 1, Agriculture, Horticulture and Forestry; No 2. Mines and Mining; No. 3, Manufactures and Liberal Arts; No. 4, Fine Arts; No. 5, Electricity and Machinery; No. 6, Auditorium; No. 7, the Nebraska Building; No. 8, Grand Army of the Republic Building; No. 9, the Silver Palace.

The Exposition will open June 1 and close November 1, 1898.

The Great Siberian Railroad and the Present State of its Construction.

(Special Correspondence to the *American Engineer, Car Builder and Railroad Journal.*)

According to the preliminary plan of construction of the great Siberian Railroad, outlined by the late Emperor Alexander III. in his rescript addressed in May, 1891, to the Czarewitch, this line was designed as a continuous trans-Siberian railroad.

This line, beginning at Chelabinsk, near the boundary between European and Asiatic Russia, and ending in Vladivostok on the Pacific Ocean, and, together with the system of Russian railroads, destined for connecting the Baltic Sea with the Pacific, was for the sake of facility of construction divided into the following separate lines:

	Miles.
The Western Siberian Railroad	885
The Central Siberian Railroad	1,149
The Baikal loop line	195
The Transbaikal Railroad	689
The Amour Railroad	1,111
The North Oussouri Railroad	227
The South Oussouri Railroad	252

So that the total length of the railroad in Asiatic Russia was designed to be 4,507 miles, and the total distance from St. Petersburg to Vladivostok, or from Baltic Sea to Pacific, was estimated at 6,232 miles.

The surveys for the Central Siberian, the South Oussouri and the Transbaikal line were made in the years 1887-88, and for the Western Siberian Railroad only in 1891. The surveys of the North Oussouri Railroad were made in 1894, and the construction of the South Oussouri Railroad and the surveys of the Amour Railroad were made only in 1894-95.

The construction of the Great Siberian Railroad has commenced on the South Oussouri line, the beginning of construction being inaugurated by the Czarowitz (now Emperor Nicolas II.) in May, 1891. Then the construction of Western Siberian Railroad began in 1892; that of Central Siberian in 1893 and that of North Oussouri and of Transbaikal in 1894. The Loop Baikal line and the Amour Rail road are not yet commenced, and probably will not be constructed; for instead of the Loop Baikal line a steam ferry through Baikal Lake is designed; and instead of the Amour Railroad—the connection of Transbaikal Railroad with the Pacific will be granted by means of the Eastern China Railroad.

The present state of the different divisions of the Great Siberian Railroads will be explained in the following:

THE WESTERN SIBERIAN RAILROAD.

The Western Siberian Railroad, from Chelabinsk to Obi River, is 886 miles long: it has a branch from Chelabinsk to Ekaterinbourg (making a connection with the Oural Railroad) 148 miles long.

For the purposes of construction this line was divided in two sections: the first from Chelabinsk to Omsk (on Irtysh River) and the second section from Omsk to Obi River. The first section was begun in 1892, and the rails were laid in 1893 and 1894. The second section was begun in 1893, and the rails were laid in 1895. In order to meet the wants of the local population the traffic was opened before the finishing of the line; on the first section (Chelabinsk Omsk) in September, 1894, and on the second section (Omsk-Obi River) in October, 1895.

In October of 1896, a commission appointed by the Minister of Way-of-Communications inspected the Western Siberian Railroad, and decided that it would be opened for regular passenger and freight traffic in that month October, 1896.

The construction of the Chelabinsk-Ekaterinbourg branch began in August, 1894, and the track laying was ended in November, 1895, and in December the railroad was ready for provisory traffic.

The total cost of the Western Siberian Railroad was estimated as follows:

The first section, from Chelabinsk to Omsk	$13,412,000
The second section, from Omsk to Obi River	10,273,000
Total cost with rails and rolling stock	$23,685,000
Viz., $26,730 per mile.	
The total cost without rolling stock was estimated	$19,383,000
from which sum the Chief Engineer has effected $231,250 of economy.	

The cost of construction of the Chelabinsk-Ekaterinbourg Branch (148 miles) was estimated, without rolling stock (to be furnished by the Oural Railroad), $3,238,000, viz , $21,900 per mile, and this sum has sufficed for the finishing of the branch.

The construction of the Western Siberian Railroad was completed in October, 1896, with the exception of the bridge through Obi River and the central repairing works in Omsk, which constructions will be finished in the summer of 1897.

The construction of the Chelabinsk-Ekaterinbourg Branch was finished in the end of 1896, and the operating of that line is transmitted to the Oural Railroad, which in this way is connected with the network of Russian railroads.

The Western Siberian Railroad is quite finished—that is, it is constructed according to the original design; but the early development of the passenger and freight traffic has shown the necessity of additional works, namely, the enlargement of many passenger stations, the addition of houses for railroad employees, the addition of sidings and freight sheds at stations with great freight traffic and the increasing of the thickness of the ballast on 120 miles in marshy grounds on the second section of the railroad. All this additional work will be carried out under control of the operating administration.

The Western Siberian Railroad has encountered many perplexities in the matter of water supply and the supply of fuel, and the satisfactory solution of these questions has presented many difficulties.

The country crossed by the line of the Western Siberian Railroad (nearly following the circle of 55 degrees north latitude) consists of two great plateaux—the Ishim plateau (steppe) and the Baraba plateau (steppe). The surface is level, and has only small local depressions of ground, forming the lakes, very often filled with salt water. On the whole space between Chelabinsk and Kainsk the line only crosses three great rivers, Tobol, Ishym and Irtysh; on the section Kainsk-Obi River, only the secondary rivers (Karhat, Chulin, Chik) are met. Between Chelabinsk and Irtysh River, and especially between the rivers Ishym and Irtysh, the line is located over salt grounds with many salt lakes. Between the rivers Irtysh and Obi in the Baraba-steppe the salt ground is met only in neighborhood of Kainsk, where the northern region is covered with marshes and salt lakes.

In consequence of scarcity of flowing waters, and the unavailability of salt water furnished by the greatest part of the lakes, the water supply of railroad stations was not easy, and on many occasions, the builder was obliged to seek the subground water, and bore artesian wells.

Of the 32 water stations, eight water supplies have artesian wells, the depth of which varies from 273 feet to 651 feet, and the diameter from 4 inches to 12 inches.

All the artesian wells are of the non-flowing type and use the sub-artesian water (at the depth of about 280 feet); for the deeper boring in Karagugu to the depth of 910 feet has shown that though the water from that depth rises to the surface of earth, it is too hard and bitter and cannot be used. The sub-artesian water supplied by all the eight wells is still very hard and must be purified by chemical means (addition of lime and soda). In addition to those mentioned there were sunk in the latter part of 1896 five supplementary water supplies midway between the original stations which were found to be too far apart (more than 33 miles).

Notwithstanding this, having in view the scarcity of flowing water and the insecurity of lakes, we can expect that in the near future, with the development of traffic, the water supply of the Western Siberian Railroad will be found unsatisfactory, and the administration will be obliged to increase the number of artesian wells. Another very difficult and important question was the supply of fuel. On the whole length of the Western Siberian Railroad there are no forests, no collieries, no turf deposits, no oil pits. The great coniferous forests begin only on the other side of the Obi River, outside of the terminus of the line. All the fuel must be carried from long distances.

The fuel used in the first years of the operating period will be coal for the first 240 miles (from Chelabinsk to Makushino) and wood for the balance of the line. The coal will be supplied from the Lunenetz colliery in the Oural Mountains at the price of $4 per ton in Chelabinsk. This coal is of such quality that one ton of it is equivalent to 170 cubic feet of wood. This ratio was the basis for calculations, which have shown that now wood is more economic fuel than coal. There are great coal deposits on the left shore of Irtysh river, not far from Omsk, but they are not yet explored, and their availability is not proved.

The wood for the following 421 miles of the Western Siberian Railroad, from Markshino to Kainsk will be supplied in the great forestry region, belonging to the state, on the right shore of Irtysh River, and crossed by its tributaries Tora, Oui, Shish and Toui. The area of this region is about ten million acres, and will give 10,000,000 cubic feet wood yearly. The distance of this forest region from Omsk is about four hundred miles, and the wood will be carried by means of a river fleet belonging to the administration of the railroad and consisting of two steamers and 12 barges.

The last 187 miles of the line, from Kainsk to the Obi River, will be supplied with wood prepared on the other side of Obi River, this wood being cheaper than the coal from the Kuznetzk colliery on Tomi River.

Of course wood as fuel cannot be indefinitely used, and with the development of traffic (which now presents only three trains daily in each direction), the mineral fuel will be obligatory, and we can hope that suitable collieries not far from line will be found.

We trust that the following general data, concerning the first period of operating the Western Siberian Railroad will be of interest.

From September, 1, 1894, to the 1st of July 1896, (22 months) the traffic on the division Chelabinsk-Omsk is shown by following figures:

Passengers I., II., III. and IV. class	152,315	persons.
Settlers	189,606	"
Workmen and soldiers	33,000	"
Exiles	2,258	"

In addition to the above is the luggage of passengers and settlers.

From October 1, 1895, to July 1, 1896 (9 months) the traffic on the division Omsk-Obi River was:

Passengers I., II., III. and IV. class	37,540	persons.
Settlers, workmen and soldiers	116,026	"
Exiles	1,405	"

From December 1, 1895, to July 1, 1876 (7 months) the traffic on the Chelabinsk Ekaterinbourg branch was:

Passengers I., II., III. and IV. class	23,768	persons.
Settlers, workmen and soldiers	3,072	"
Exiles	2,409	"

The whole freight traffic on the Western Siberian Railroad and its Ekaterinbourg branch was about 200,000 tons.

The total receipts for the transportation of passengers and freights were $1,324,000, which will probably cover the working expenses.

In conclusion, we should remember that the Western Siberian Railroad, being located in a quite level country, has a very easy profile of track. The ruling gradient in the eastward direction is 0.0074, in the westward direction 0.0069. The length of level track is about 500 miles, or 56.5 per cent. of the whole. The percentage of gradients in the eastward direction (from Chelabinsk to the Obi River) is as follows: Less than 0.003, 11 per cent. of the whole; from 0.003 to 0.004, 2.7 per cent.; from 0.005 to 0.0074, 6.7 per cent. The percentage in the westward direction (from Obi River to Chelabinsk) is: Less than 0.003, 13 per cent.; from 0.003 to 0.004, 3 per cent., and from 0.005 to 0.0069, 7.7 per cent. The minimum radius of curvature is 1,400 feet and the greater part of the line is straight, the total length of curves making only 7½ per cent. of the whole.

(To be continued.)

The Gates Iron Works.

The Gates Iron Works, Chicago, several years ago initiated its policy of gradually rebuilding its entire plant by the erection of a building 78 feet by 325 feet, which is intended ultimately for an erecting shop, but at present is occupied almost wholly as a machine shop. It is a fine building for the purpose, having plenty of light, and being well heated and ventilated. The offices are in this building, occupying two floors at one end, and a gallery along the north side. The drawing-room is also on this gallery and the north exposure, with plenty of windows on that side of the room, makes one of the pleasantest and best lighted drawing-rooms we have seen.

Except for the gallery mentioned there is only the one floor under this roof. It is served by a traveling crane, built by the Morgan Engineering Company. The shop is heated by the Buffalo Forge Company's hot blast system. The power for the machine shop is furnished by electric motors. Four motors are so placed as to drive that many groups of tools, one motor driving the planers, another the lathes, a third the boring mills, etc., and the fourth furnishes power for the tool-room. The dynamos are in the engine-room, which is a separate building and supply current for various purposes throughout the entire plant. For night work, when a few tools only are operated in the machine shop, the blower engine of the heating system is made to furnish the power. It is in the shop and so arranged as to be quickly connected up.

In the course of a recent tour through the shops we noticed a number of interesting things. The tool-room is well equipped and is located under the gallery and directly beneath the drawing-room. A two-story vault gives fireproof storage for the tool-room and drawing-room. The second floor is used for the safe keeping of valuable drawings, while the first floor is occupied by gages and templets of various kinds. When one thinks of the immense sums that are locked up in templets, gages and special small tools required in a first class shop, the construction of a vault for their safe keeping will appear as a most natural precaution. And yet this is seldom done; in fact we do not remember to have seen it done before. The company figure that they have more money invested in the contents of this vault than in any space of the same size anywhere about the plant.

We noticed an ingenious grinding attachment for a lathe, which consisted of a small grinder driven by a diminutive electric motor, the whole device being self-contained and mounted on the cross-slide of the carriage. It can be quickly attached to any lathe, and besides using it for miscellaneous grinding operations it is employed for truing up all lathe centers and arbors.

The work done in this company's foundry is of a most interesting character. Not only are many heavy castings of various shapes turned out, but in their ore and rock crushers, rolls, etc., there is needed a very hard material. Manganese steel and other special mixtures have been tried for crusher jaws, but more or less difficulty has been found with them, and the company has concluded that the best results can be obtained from chilled cast iron. These crusher jaws must be so made that they can wear five inches of metal from their faces before being discarded, and consequently the depth of chill must be at least equal to that figure. We saw some castings that had been broken under the drop and whose fracture showed a chill between five and six inches deep. This result has not been obtained without much special investigation and study. A laboratory adjoins the main foundry, room and in it is placed a small test cupola, where special mixtures are melted and the qualities of the resulting metals tested. The company also has what it calls its gear mixture, used for gears and castings that must stand equally hard usage, and one-inch test bars cast from this metal must show a strength of 3,000 pounds when placed on supports 12 inches apart. They actually average about 3,500 pounds, but they would be rejected if they fell below 3,000 pounds.

The foundry floor is served by a Yale & Towne traveling crane, which is believed to be the first built by that concern. It has in recent years been supplied with electric motors.

The Gates Iron Works has recently added to its line of products the Fischer engine, as already noted in the pages of this journal. Several sizes of this engine were on the floor in a partially completed state at the time of the writer's visit. The engine business is not a new one to the company, as it has for years built an engine of the Corliss type for parties who were willing to pay for a high-grade engine. It is preparing to do a large business with the Fischer engine.

The publishers of the Official Railway Equipment Register and the Pocket List of Railroad Officials announce that increased facilities having become necessary, the publication offices have been removed from Pearl street to Room 17, 24 Park place, New York City.

The tests made with liquid fuel on the Russian torpedo-boat *Viborg* during October, 1896, proved so satisfactory and showed such advantages that all torpedo-boats having locomotive boilers are to be fitted to burn *masut* as well as coal. The torpedo-boats having water-tube boilers will not be so fitted until tests have been made on the six boats now building, and which are to have Du Temple boilers fitted for liquid fuel. Part of the present coal bunkers will be arranged into compartments which will have a capacity of 3.25 tons of *masut*. The trials on the *Viborg* showed that it was very important to give special attention to the first filtration of the *masut*.—Journal of Amer. Soc. Naval Eng.

The Barnes' Feed-Water Heater for Locomotives.

In the accompanying illustrations we show the construction of a feed-water heater designed by Mr. J. Barnes, Superintendent of Motive Power of the Wabash Railroad, and used by him on the locomotives under his charge. It is, in brief, a method of utilizing the exhaust steam from the air-brake pump for heating the water in the tank. The amount of steam used by a pump is con-considerable, and it appears from actual experience that the heat recovered by turning that steam into the tank is sufficient to make the water as hot as the injector can work it. In writing to us about it Mr. Barnes says:

"The feed-water heating arrangement is very simple; it consists of a three way valve in front of the pump, a lever controlling the direction of the exhaust, putting it into the stack or into the tank, a 1¼-inch pipe running in both directions from the valve to stack and from valve back into tank through the separator, and steam hose and connection as shown by print. The purpose of the separator shown is to catch any oils or other foreign matter which would otherwise be carried into the boiler through the feed water. It can be readily blown out two or three times a trip, as occasion may require. The use of this device is merely precautionary. Around the bottom of tank lies a 2½-inch pipe with 15 upright pipes with Tee connections, all of the same dimensions as the horizontal pipe mentioned. At the end of each vertical pipe is a goose-neck attachment with a reduced nozzle ½ inch in diameter (see Fig. 3) except the last one at the end of horizontal pipe, which has a nozzle attachment of one inch in diameter. The object of the larger opening in the one pipe is to induce the exhaust to follow the horizontal pipe to the end, carrying with it the condensation falling from the other upright pipes with the smaller openings, which smaller openings are for purpose of assisting in giving vent to the exhaust and keeping the uprights heated. Should the water become too warm for the injector, the operator easily turns the exhaust into the stack. The water in tank can be heated to 100 degrees Fahr. and more. Any injector of modern make will readily work at that temperature. As the water recedes in the tank, less heating surface is in contact with water, hence the tendency is for the water to remain at an even temperature.

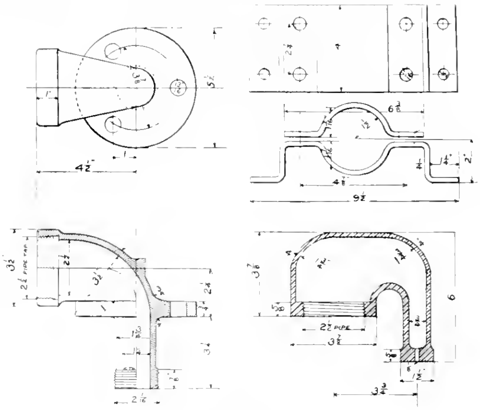
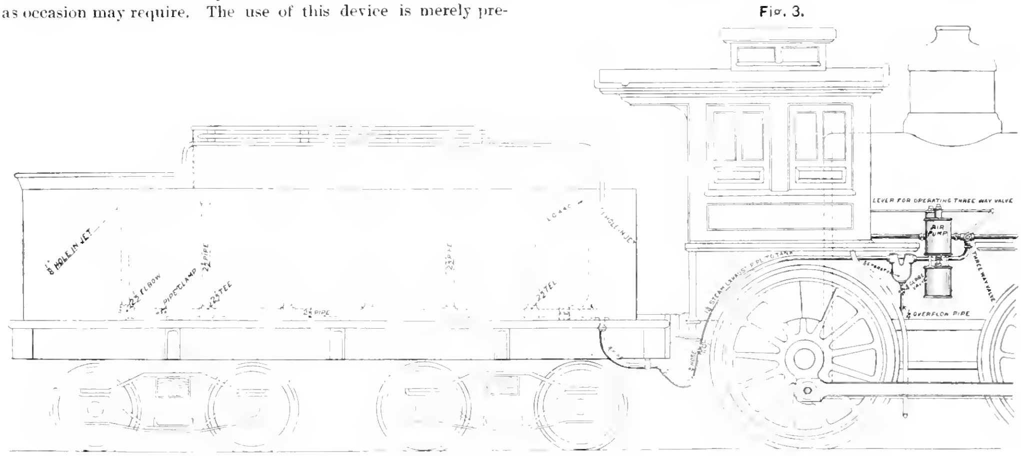


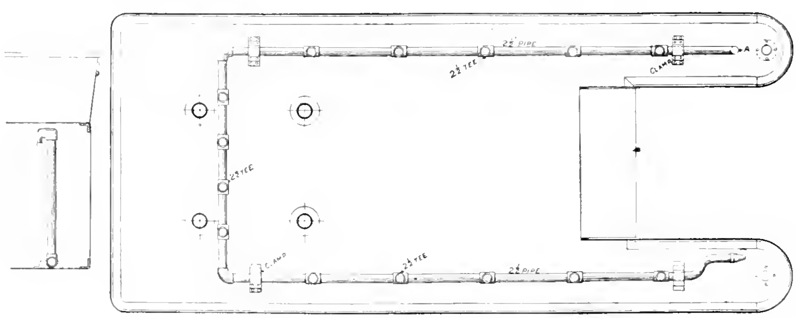
Fig. 3.



The Barnes Feed-Water Heater.—Fig. 1.

"There is no question as to great results from this device as a fuel economizer. Then again its practical utility in diverting the steam pump exhaust from the front end into the tender is simply getting rid of a nuisance at no expense, and putting it where it is of real benefit, in addition to the great saving in fuel."

A patent has been applied for on this device and already quite a number of roads are arranging to use it. It certainly appears to be one of those things which, without adding a complication of parts, reduces the waste of fuel in one direction to a minimum.



The Barnes Feed-Water Heater.—Fig. 2.

The Pyle-National Electric Headlight.

The manufacture of electric headlights must, in even a greater degree than the makers of other first-class machinery, combine in their apparatus, simplicity, reliability, efficiency and the minimum of bulk, cost and maintenance. Many railroad officers are in favor of electric headlights, but are looking for a simple and less expensive mechanism than has yet been offered them.

The improved electric headlight patented by Mr. Geo. C. Pyle, and placed on the market by the Pyle-National Electric Headlight Company, of Chicago, presents these desirable features to a greater degree than any headlight in the market. Its general appearance and special features are shown in the accompanying engravings, in which Fig. 1 is a section through the dynamo and motor, Fig. 2 is an exterior view, Figs. 3 and 4 are views with parts of the casings removed, and Fig. 5 is a view of the lamp. The current-generating apparatus consists of a compound steam turbine and a dynamo mounted on the same shaft and occupying a space only 26 inches by 18 inches wide. This is mounted on the smokebox between the headlight and the stack, the space required being 19 inches.

The turbine is an interesting piece of mechanism. It consists of a casing in two parts, *A* and *B*, Fig. 1, within which is the disk *C*, mounted on a shaft 1$\frac{1}{16}$ inches in diameter. The steam is admitted at *D*, and by means of four ports passes to the buckets *E*. The disk has five series of buckets, *E*, *F*, *G*, *H* and *I*, against which the steam acts before it is exhausted. The shape of these buckets was determined after careful experiment, and as a result the two outer series, *E* and *F*, are curved, while the others are straight and are set at an angle of 45 degrees. The clearance between the buckets and the fixed deflectors is $\frac{1}{20}$ of an inch. The steam after leaving the last bucket escapes through an exhaust pipe attached either at *J* or *J*¹, and leading into the stack or the smokebox, as desired. The governor is simple and ingenious, and is said to be very effective. It consists of a thin ring, *K*, adapted by a lateral movement to throttle the steam at the openings by which it enters the buckets *E*. The ring is held in position by four flat springs *M* (seen in Figs. 1 and 3), whose tension is adjusted by screws. The ring is also acted upon by four small weights, *L*, so placed that their centrifugal force acts in opposition to the springs. When running at normal speed the balance between the weights and springs keeps the ring in a position to give the required steam admission, and if the speed begins to change the force of the springs or the weights shifts the ring to meet the conditions and keep the speed within close limits. The normal speed is 1,900 revolutions and the regulation is within 25 revolutions between full load and no load.

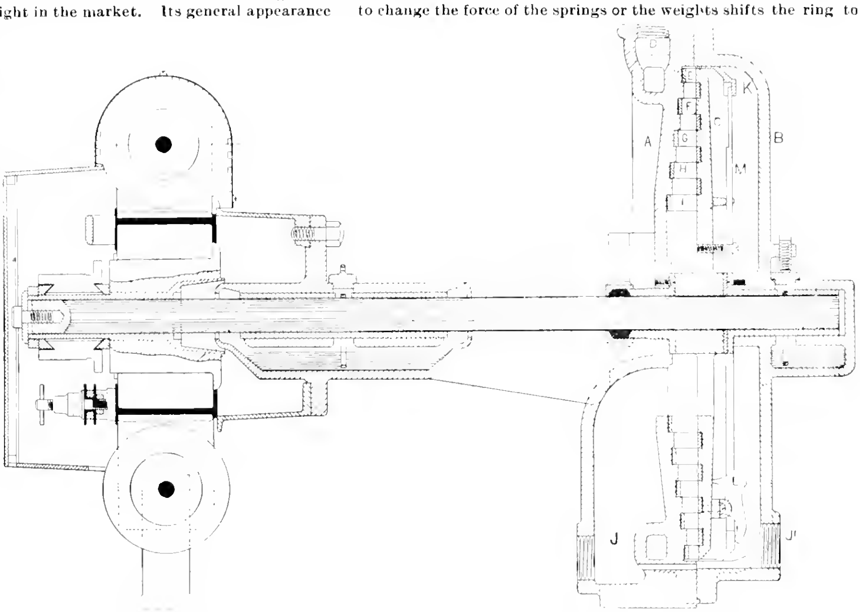


Fig. 1.—Section Through Turbine and Dynamo.

The steam pressure employed is about 25 pounds under the boiler pressure and a $\frac{3}{4}$-inch pipe furnished the supply. The exhaust pipe is 1$\frac{1}{4}$ inches in diameter. The combined area of the four steam ports is less than the area of a $\frac{1}{4}$-inch pipe.

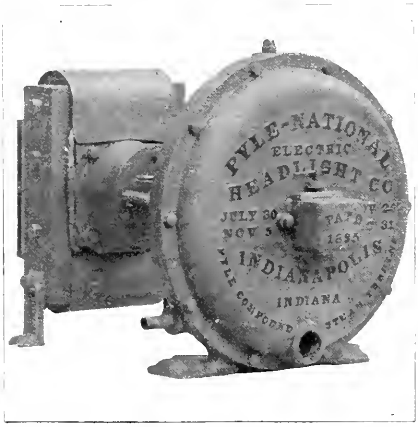


Fig. 2.—The Pyle-National Electric Headlight.

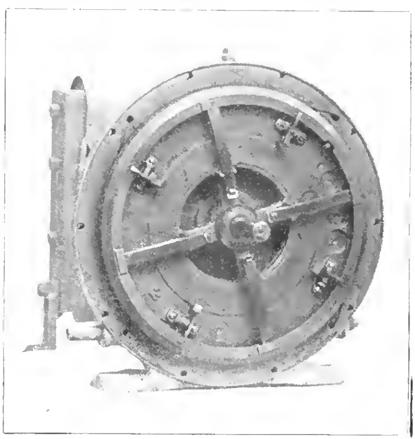


Fig. 3.—Headlight With Casing Removed From Turbine.

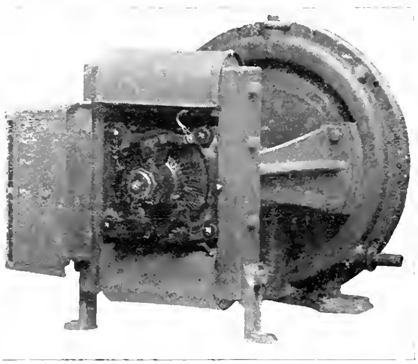


Fig. 4.—Headlight With Casing Removed From Dynamo.

The dynamo is very compact. The frame is of wrought iron and the armature is of the Gramme type with 240 turns of wire; there are 40 sections to the commutator. The brush holders are fixed and one brush is of pure graphite, while the other is a regular carbon brush. They can be removed without changing the tension of the springs. The dynamo generates a current of 25 amperes at 30 volts when running at 1,900 revolutions. As 450 watts are generally considered sufficient for a 2,000 candle-power lamp, it is evident that this dynamo will furnish between 3,000 and 4,000 candle-power at the lamp.

The weight of the armature, shaft and turbine disk is only 41 pounds, and the total weight of the turbine and dynamo is only 250 pounds as compared with 780 pounds in the old types of electric

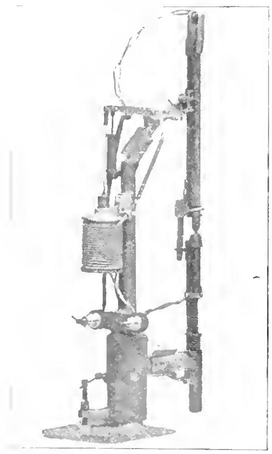


Fig. 5.—Lamp for Pyle-National Headlight.

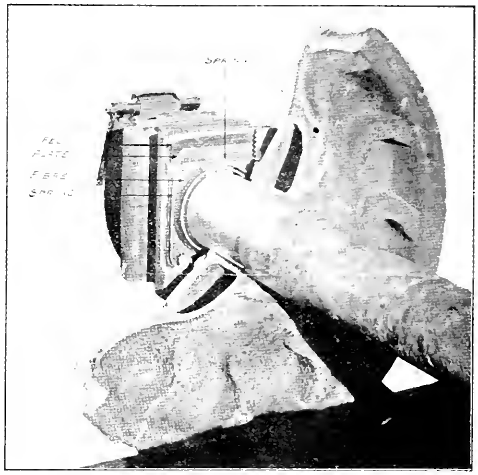
headlights. The bearings are of bronze and the lubrication is as near perfect as is attainable.

The arc lamp is shown in Fig. 5. The lower carbon is held by a spring against a stop so that its upper end is always in the same position. The upper carbon passes through a ring, the hole in which is slightly larger than the carbon. When the ring is horizontal the carbon can slip through it, but if tipped slightly it holds the carbon. The movements of the ring are controlled by a wire attached to a lever actuated in one direction by a spring and in the opposite direction by a solenoid in the lamp circuit. When the dynamo is first started the spring keeps the carbons in contact, but as the current increases the solenoid acts to separate them and establish the arc. The mechanism is designed to use up almost the entire length of the carbons and one set of them will last about eight hours. The cost for carbons is under two-tenths of a cent per hour.

The improved light has been in use for over a year on the Wilmington & Northern, the Plant system, the Vandalia and the Big Four roads, and on the Chesapeake & Ohio since November, 1896. The light has proved to be very steady and satisfactory in every respect. The cost of maintenance has been reduced to a remarkably low figure, and the first cost is only about one-half the price at which the earlier headlights were quoted. Mr. Royal C. Vilas is President of the company; Mr. G. C. Pyle, Electrician, and Mr. Mark A. Ross, Sales Agent. The offices of the company are in the Monadnock Block, Chicago, Ill.

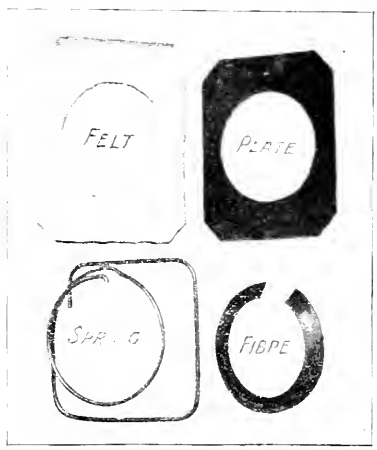
The Symington Dust Guard.

Mr. T. H. Symington, M. E., Assistant Superintendent of the Richmond Locomotive Works, has had in service for some time past a



The Symington Dust Guard.

dust guard of his own invention, and for which excellent results are claimed. We show the dust guard in the accompanying illustrations. It consists of a piece of $\frac{1}{8}$-inch iron, backed by a similarly shaped piece of felt. A ring of flexible vulcanized fiber is pressed against the plate by a spiral spring of $\frac{1}{4}$-inch steel wire, which spring



The Symington Dust Guard.

also presses against the rear wall of the dust guard slot or pocket in the journal box. This pressure holds the felt against the surface of the front wall of the pocket. Joints are thus maintained between the plate and the box, and between the ring and the plate.

The spring pressing on the beveled side of the fiber ring produces a slight but constant pressure tending to close the ring on the axle, thus giving a tight joint all around the axle. A length of 2 inches is cut out of the ring on top of the axle, allowing it to close about $\frac{3}{4}$ of an inch as it wears. Where the opening in the ring occurs, the plate rests lightly on the axle and completes the joint. The spring is prevented from turning in the dust guard pocket by having its outer coil made square. One end of the spring is bent down between the ends of the fiber ring, thus preventing it from turning and keeping the opening in the ring at the top of the axle.

To apply the dustguard, the felt is first put in the slot; then the iron plate, which is bored $\frac{1}{16}$-inch larger than the axle. The spring is then compressed in the hands, and with the ring pushed into place through the top of the slot. A piece of wood or iron is then put between the ends of the fiber ring holding it open $\frac{1}{16}$-inch larger than the axle, and is pulled out through the top of the slot after the box is put into place. The ring is then closed on the axle by the spring. Roundhouse men have found it easier to apply than the ordinary guard, because the hole is $\frac{1}{16}$-inch larger than the axle, when the box is being put in place.

After 18 months' continuous running, an axle having this guard applied to it was carefully examined, and no mark could be found where the plate or spring touched it, nor was there any appreciable wear of the plate. The plate was worn $\frac{1}{16}$-inch larger than its original size. The brasses were carefully weighed before and after the test. A saving of 46 per cent. in wear of bearings was shown with the Symington Guard over the ordinary guard on the same truck. The saving of oil and protection against hot boxes may be inferred. The price of the guard is stated to be about 20 cents.

A Large Rand Compressor.

A recent issue of a Canadian paper contains an interesting dispatch from Rossland, B. C., regarding the christening and starting up of a large Rand compressor recently installed in the Le Roi mine at that place. The compressor will be known as the "Senator" and will be used for running all the pumps and hoists at the mine in addition to operating 40 drills. It is described as a beautiful piece of mechanism in every detail of its construction and is fitted with the latest type of mechanical air valves, automatic governors, etc. It has the distinction of being one of the three largest compressors in use in the great Northwest. The machine is a Rand air compressor of the latest improved type with Corliss compound condensing engine; size of steam cylinders 22 and 40 by 48 inches stroke; air cylinders, 22 and 34 by 48 inches stroke, with intercooler.

The Rand Drill Company, 100 Broadway, New York, builders, reports a steadily increasing demand for their compressors and drills for mining purposes, and claim that they make the most efficient, economical and durable machines for this class of work on the market.

New Publications.

POWER DISTRIBUTION FOR ELECTRIC RAILROADS. By Louis Bell, Ph. D. Street Railway Publishing Company, 26 Cortlandt street, New York, 1897.

In this volume the author has endeavored to set forth the general principles of the distribution of electrical energy to moving motors, to describe the methods which experience has shown to be desirable in such work, and to point out the way in which those principles and methods can be co-ordinated in every-day practice. He believes the apparatus employed is for the most part too mutable to describe exhaustively, unless one is writing history, and hence he gives little of such detail in this work. Some idea of the scope of the work can be obtained from the titles of its chapters, which are as follows: I, Fundamental Principles; II, The Return Circuit; III, Direct Feeding Systems; IV, Special Methods of Distribution; V, Sub-stations; VI, Transmission of Power for Sub-stations; VII, Alternating Currents for Railway Work; VIII, Interurban and Cross-Country Work; IX, Fast and Heavy Railway Service.

The book is most interestingly written and is up to date in every respect. The chapter on inter-urban roads, while giving considerable attention to narrow gage and single rail lines, makes clear the important part which electricity can take in the development of localities by means of light and comparatively cheap lines of transportation. The chapter on fast and heavy railway service does not deal so much with electricity in general railway work as it does to the following three special cases: 1. Heavy local passenger traffic; 2, high speed inter-urban traffic; 3, elevated roads, tunnels and special service. The general principles of such transportation and the details pertaining to it are discussed. The power required, the features of line construction and such data as is necessary to determine the cost in any given case are presented in a clear manner. The author discusses a case of traffic at 100 miles per hour in which the train resistance, air resistance and other factors in the problem are given positive values with a freedom that a steam railroad man would envy. The figures may be right, but no one in steam railroad practice is sure of it. On the whole, however, the subjects are treated in a manner beyond criticism.

Trade Catalogues.

[In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. These are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

AUTOMATIC HOISTING AND CONVEYING APPLIANCES. Brown Hoisting and Conveying Machine Company, Cleveland, O. 76 pages, $5\frac{3}{4}$ by $10\frac{1}{2}$. (Not standard size.)

This company designs and manufactures special machinery of all kinds for handling materials in large engineering undertakings and manufacturing processes, and ore, coal, etc., from vessels, docks and mines. The company is the sole proprietor of the patents on the mechanical devices invented by Mr. Alexander E. Brown, C. E., the Vice-President and General Manager, and also of the patents on cranes formerly controlled by the Yale & Towne Manufacturing Company, of Stamford, Conn., whose entire crane business was purchased by the company in December, 1894, and added to their crane department. This catalogue is issued from the company's Western office, in Chicago, and illustrates such a variety of machinery that it is difficult to give it an adequate mention in a notice of this kind. Almost every large installation of hoisting and conveying machinery has been adapted to meet special conditions and consequently differs more or less from all other plants. It is in meeting the requirements of each situation that the enterprise and engineering ability of this firm has gained such a marked recognition everywhere.

Most of the engravings, of which there are about 30, are full-page illustrations of notable installations. The first of these is a movable bridge tramway hoisting and conveying apparatus for coal and ore on the C. & P. R. R. docks at Cleveland. Another is five-span cable tramway apparatus on the N. Y., P & O. dock in the same city. Cantilever cranes of various kinds are also illustrated, including those used on the Chicago Drainage Canal, with arms extending over 350 feet, and others used in ship yards, docks and in industrial establishments. Bridge traveling cranes, movable bridge tramways cable tramways, shed tramways, movable tramway systems for sewer construction, and traveling cranes of many kinds are described and illustrated. A valuable feature of the book is that it not only gives the dimensions and rated capacities of the various plants, but in many cases gives the quantities of material actually handled per day, week or month in actual service. The catalogue will be found of interest and value by all who are concerned in the economical handling of materials of any kind.

REFRIGERATION, AND THE MACHINERY TO DO IT IN THE MOST RELIABLE AND ECONOMICAL WAY.—Westinghouse, Church, Kerr & Company, Engineers. New York, Pittsburg, Boston, Philadelphia and Chicago. 24 pages, 6 inches by 9 inches. (Standard size.)

This interesting pamphlet opens with a caution to "start right" when getting a refrigerating plant. "A good compressor is the main root of good refrigeration; but it is only one root. Refrigeration, perhaps more than any other mechanical process, must be good at each step to be profitable, and the machinery by which it is handled must be as perfect as the results desired. A poor compressor will spoil the best job ever put up, while a perfect compressor is almost worthless when attached to improperly designed or poorly constructed piping. The refrigerating plant as a whole is a poor investment unless it is backed by reliable insulation to keep the heat out of the places it has cooled.

"It is one thing to produce good refrigeration and another to

keep it. Suppose a box built without any doors had walls so perfectly insulated that no heat could get through them. If cooled down to freezing it would stay there forever without further refrigeration. No insulation is perfect, so some heat always works through and the size of the refrigerating plant and the cost of running it depends largely on how much heat gets in. You can't have insulation too good. It saves money. Purchasers sometimes wonder why refrigerating plants scatter through such a range of price. The reason is that some contain only poor work and inferior machinery, others are partly good, while some are strictly first-class throughout. If refrigeration is worth doing at all, it is worth doing in a substantial, efficient way, insuring a durable plant and a money-saving service."

The requirements of a good ammonia gas compressor are then outlined and the independent, self-contained compressor furnished by this firm is described and illustrated. This compressor is usually belt-driven and the pin of the crank on the main shaft works in a yoke to which two single-acting pistons are attached. There are two cranks and four cylinders in the larger sizes and one crank and two cylinders in the smaller ones. In their construction and in the details of design they are as near perfect for the work required as it is possible to make them.

The condenser advocated by this firm is one of their own design. It is vertical, made in sections of about one ton capacity, and with this unit any size can be built up. Each section is a row of pipes with top and bottom headers. The water flows in a thin film down each pipe without spattering, and by the thinness of the film great economy in water results, as some is vaporized, which action is increased by the upward currents of air, making it in part an evaporative and air condenser. This is of much importance where the water supply is limited or expensive, as in cities. The condenser may be in or out of doors, usually the latter, where it occupies room of no value, and in cool weather requires little or no water.

Some space is given to the character of pipe and pipe fittings necessary for good work. The fact that refrigerating is high-class work from an engineering and scientific standpoint is also rightly insisted upon. The pamphlet contains many full-page engravings of excellent quality, showing clearly the principal features of a number of interesting plants. The New York office of the company is at 26 Cortlandt street.

Air-Compressors. The Ingersoll-Sergeant Drill Company, Havemeyer Building, New York. 64 pages, 6 by 9 inches. (Standard size.)

This neat catalogue is really the advance sheets of Catalogue No. 31, and is devoted entirely to air-compressors, if we except the few pages at the back, on which air-receivers, tanks and reheaters are illustrated. The compressors illustrated include almost every conceivable type—straight-line, single, compound, duplex, half-duplex and triple—and driven by steam, electricity, Pelton wheels, turbines, belts or gears. The company has had an experience of over 25 years in the manufacture of compressors, and those years have been years of great progress in the devolopment of this class of machinery, to which this company has contributed its full share. The excellence of their work may be judged by the engine friction as ascertained by Professor Jacobus at the World's Fair, which was found to be less than five per cent.

It would be impossible in the limits of our space to describe the many designs of compressors illustrated in the catalogue. Those who want to study them should send for copies for themselves. We would mention particularly, however, the class "G" compressor, which is quite extensively used in railroad shops. It is a duplex machine, but is also furnished as a half duplex. It is possible, also, to install the half-duplex and purchase the other half when the demand for air has increased sufficiently to require it. These compressors have piston inlet air-cylinders, water jackets on both barrel and heads of the air-cylinders, and are provided with a governor, an automatic pressure regulator and an unloading device on the air-cylinders.

The catalogue is of value to all who are interested in air or gas compression to any pressure and for any purpose whatever.

The Strength of Culvert Pipe.

The Blackmer & Post Pipe Company, of St. Louis, manufacturers of culvert and sewer pipe, recently decided to test the external pressure its large sizes of pipe would stand without breaking, and believing that reliable information would be desirable in making comparison of the merits of brick sewers and pipe sewers, it selected from the stock on our yard the following material: Two sections 24-inch double strength culvert pipe; two sections 27-inch double strength culvert pipe; two sections 30-inch double strength culvert pipe; two sections 27-inch standard culvert pipe; one section 30-inch standard culvert pipe. This material was sent to the works of the Geo. J. Fritz Foundry and Machine Company, 2038 South Third street, St. Louis, where each section of pipe was tested in the following manner: In making the tests blocks of wood were hollowed out to fit as nearly as practicable the shape of the pipe, each block covering a little less than one-fourth the circumference of the pipe. The pipe was then placed in an hydraulic press, the power being supplied by a hand pump, the pressure being registered on the gauge as applied. Inasmuch as the blocks were of hard material, and it is extremely difficult to make them conform exactly to the contour of the pipe when pressure is applied, the results of the tests can hardly be called a fair or full measure of the strength of the pipe, but the resistance of the pipe as shown clearly proves its strength to be more than sufficient for its legitimate use. Indeed, when the pipe is properly laid, with its entire lower surface solidly bedded in the ground, it would appear, in the light of the foregoing tests, that the pipe could not be broken by the weight of earth above it, no matter how deep the cut.

The actual results of the tests were as follows:

One section 24-inch double-strength culvert pipe, 2 inches thick, broke at 27,610 pounds.

One section 24-inch double-strength culvert pipe, 2 inches thick, broke at 28,715 pounds.

One section 27-inch double-strength culvert pipe, 2¼ inches thick, broke at 33,133 pounds.

One section 27-inch double-strength culvert pipe, 2¼ inches thick, broke at 32,763 pounds.

One section 30-inch double-strength culvert pipe, 2½ inches thick, broke at 27,987 pounds.

One section 30-inch double-strength culvert pipe, 2½ inches thick, broke at 24,297 pounds.

One section 27-inch Standard culvert pipe, 2⅛ inches thick, broke at 23,986 pounds.

One section 27-inch Standard culvert pipe, 2⅛ inches thick, broke at 22,530 pounds.

One section 30-inch Standard culvert pipe, 2¼ inches thick, broke at 27,875 pounds.

The Steel-Tired Wheel Company.

The Steel-Tired Wheel Company, which was incorporated in New Jersey in January, with an authorized capital of $4,000,000, has purchased the plants, materials and business of the Allen Paper Car-wheel Company, the Boies Steel Wheel Company, the McKee, Fuller and Company, the Page Car Wheel Company, the Ramapo Wheel and Foundry Company, and the Washburn Wheel Company. The Krupp wheel business, as represented by Messrs. T. Prosser & Sons is independent of the new company, as are also the Standard Steel Works and the Taylor Iron and Steel Company. The officers of the new company are: President, J. E. French, formerly of the Paige Car Wheel Company; First Vice-President, W. W. Snow, of the Ramapo Wheel and Foundry Company; Second Vice-President, C. H. Antes, formerly of the Allen Paper Car Wheel Company; General Manager, W. W. Silverthorn, formerly of the Paige Company; Treasurer, J. C. Beach, formerly of the Allen Company; Secretary, W. W. Turlay, formerly of the National Car Wheel Company. The Directors of the new company are the officers above, also H. M. Boies, of the Boies Steel Wheel Company, and W. M. Barnum.

It is expected that the new company will be able to reduce the prices of wheels to consumers, not so much through a reduction of the cost of manufacture as in the saving of administrative expenses and the cost of selling, which can be greatly reduced under the new arrangement. The wheel works purchased by the company will continue to be operated. The offices of the company are in the Boreel Building, 115 Broadway, New York.

Paint for Metal Surfaces.

The evidence is accumulating in favor of graphite paint as the paint of the future for the protection of all exposed iron and metal work. Professor Spennrath, Director of the Technical School of Aix-la-Chapelle, lately won the $2,000 prize offered by the Society for the Advancement of the Industrial Arts for the best essay on Protective Paints. The prize was not won simply by theoretical demonstrations, although the professor furnished scientific reasons also, but by most carefully conducted practical experiments with various pigments and oils, covering several years' time. The results demonstrated that a properly made paint of graphite and boiled linseed oil is the most suitable for protecting structural iron work, roofs, etc., exposed to the destructive agencies of heat, cold, storms, etc. Running parallel with these results are the facts demonstrated by those who have used Dixon's Silica Graphite Paint during the past 30 years. Roofs and iron work properly painted with that paint have not required painting in 15 to 20 years. Those interested should investigate for themselves the merits of this paint. The Joseph Dixon Crucible Co., of Jersey City, N. J., can furnish much information of a convincing character.

EQUIPMENT AND MANUFACTURING NOTES.

The Pennsylvania Company is in the market for 200 cars.

The Pittsburgh & Lake Erie is asking bids on 1,000 cars.

The Vandalia is reported as being in the market for 150 freight cars.

The St. Louis, Vandalia & Terre Haute is in the market for 175 cars.

The Rio Graude Western is receiving bids on 100 stock and 100 coal cars.

The Houston & Texas Central is said to be in the market for five locomotives.

The Savannah, Florida & Western is receiving bids on a lot of freight cars.

The Lake Shore & Michigan Southern is asking bids on five switching engines.

The New Orleans & Southern Railway will soon place an order for two locomotives.

The Brooks Locomotive Works have received an order for 25 engines from the Mexican Central.

The Ensign Manufacturing Company is said to have an order from the Chesapeake & Ohio for 100 cars.

The Atchison, Topeka & Santa Fe is in the market for ten 10-wheel locomotives. It will build 15 others in its own shops.

The Haskell & Barker Car Company has received the order from the Chicago, Hammond & Western for 100 stock and 40 flat cars.

The order of the Pittsburgh, Bessemer & Lake Erie for steel cars will, it is reported, be for 600.

The Schenectady Locomotive Works has received an order from the C., C., C. St. & L. Road, for two eight-wheeled passenger engines.

The Erie Railroad has contracted with the Rogers Locomotive Company for 24 Wootten boilers, to be delivered at the rate of two a month.

The Pennsylvania Railroad Company has ordered Pancoast ventilators on the new passengers cars now being constructed at the Altoona shops.

The Mexican Central Railroad has placed an order with the Michigan Peninsular Car Company at Detroit for 325 box cars, 150 coal cars and 75 stock cars.

The Kansas City, Pittsburgh & Gulf has ordered 20 caboose cars, with 28-foot bodies. It has placed an order for 400 box cars with the Missouri Car & Foundry Company, of St. Louis.

The Pennsylvania Railroad will build at its Juniata shops 10 mogul freight engines, for use on the P., C., C. & St. L. It is stated that 10 class L passenger locomotives will also be built.

The Manitou & Pike's Peak Railroad has received a new compound engine from the Baldwin Locomotive Works. The engine weighs 25 tons and its cylinders are 10 and 15 by 22 inches.

The receivers of the Baltimore & Ohio have ordered from the South Baltimore Car Works 260 coal cars, to be delivered in May. They have also ordered 2,500 freight cars from the Pullman Works.

It is reported that in addition to the 10 engines ordered of Baldwin Locomotive Works, the Kansas City, Pittsburgh & Gulf has contracted with the Manchester Locomotive Works for eight more.

The Cold Blast Transportation Company, of Kansas City, Mo., has placed an order with the Wells & French Company, Chicago, for 100 refrigerator cars, and will soon place an order for another one hundred.

The Chicago & Eastern Illinois Railroad has let a contract for 350 coal cars of 80,000 pounds' capacity to the Haskell & Barker Car Company, of Michigan City, Ind. The cars will be equipped with Tower couplers.

The Baldwin Locomotive Works recently received orders for one engine for the Spokane Falls & Northern Railroad, two for the Rio Grande, Sierra Mádre & Pacific Railroad and one for the New York, Chicago & St. Louis.

The Baldwin Locomotive Works will build for the Philadelphia & Reading Coal & Iron Company a compound compressed air locomotive. This is a novelty, as it is uncommon to use compound cylinders in compressed air locomotives.

The Morgan Engineering Company, of Alliance, O., has received an order for three electric traveling cranes for Jones & Laughlin, of Pittsburgh. Two of them will have a span of 40 feet and the third 80 feet. All are of 10 tons' capacity.

The office of Secretary and Treasurer of the Sterling Railway Supply Company, is now at the company's works, Easton, Pa., to which place all future communications should be addressed. The soliciting office will remain at 256 Broadway-House, Life Building, New York.

The Rand Drill Company has received an order for a deep wet air lift pumping plant for Norwood, O. The capacity is 1,000,000 gallons of water in 24 hours. It has also received an order from the Atchison, Topeka & Santa Fe for an air compressor, making eight that the Rand Drill Company has now sold to the road.

The Richmond Locomotive & Machine Works have recommenced work with a large force of workmen. Secretary G. F. Jones states that the force will be daily increased, new men being taken on as opportunity offers. The reopening of this plant will furnish work to a large number of mechanics who have been unemployed for weeks.

From Mr. J. Faessler, manufacturer of the "Boss" and improved sectional expanders as well as other tools and machines, we learn that his business is steadily increasing, the past year being the best year in the history of his shop. He says he keeps his old customers and gets new ones right along, which speaks well for the tools he furnishes them. Send for his new catalogue and keep posted.

Mr. I. P. Richards, Providence, R. I., manufacturer of punches with a double shearing cut, has recently gotten out a new and attractive illustrated circular descriptive of his goods. Mr. Richards is the original designer of that style of punch, and claims that his system of punches is the best and plainest arranged of any system in use. He states that all the builders of punching machinery have adopted it as far as possible.

The firm of Bement, Miles & Company, of Philadelphia, have recently shipped to the Bethlehem Iron Works a horizontal boring and milling machine weighing about 110 tons. They also have under construction in the shops for the same company a planing machine which will handle work 30 feet long and 8 feet high, designed for armor plate work. Both machines are of unusually large dimensions and embody special features.

The corporation heretofore doing business in New Jersey, New York and elsewhere, under and by the name of "W. A. Crook & Bro.'s Company," has recently, pursuant to the laws of the State of New Jersey, under which such corporation was and is organized, changed its corporate name from that of "W. A. Crook & Bro's Company" to that of "Lambert Hoisting Engine Company," under which latter name it will continue to do business in the same line as heretofore. Lambert Hoisting Engine Company will receive all the assets and pay all the liabilities of the W. A. Crook & Bro's Company.

The D'Este & Seeley Company report, among their recent sales, five large, flanged, composition, pressure regulators, to the Atlantic Works, Boston, for a steamer, to reduce 160 pounds boiler pressure to 80 pounds, for general use in steering, hoisting, cooking, heating, electric-light plant, etc. Also, several large regulators for use with the Paul steam system of low-pressure heating and drying. These regulators work on vacuum of 2 to 12 inches. Also, 17 targe flanged regulators on an order from Copenhagen, Denmark. They have also quite recently furnished several large composition, flanged regulators for the steam yacht of the Emperor of Russia.

The Edward P. Allis Company, of Milwaukee, Wis., has purchased the business formerly carried on by the Hercules Iron Works, the Hercules Ice Machine Company and the Reliance Engineering Company, of Aurora, Ill., and is prepared to supply repairs on all ice and refrigerating plants erected by them, as well as to build new refrigerating machinery of any capacity from 1 to 500 tons' refrigeration. This well-known firm thus adds an important line of machinery to its already extensive output, and will undoubtedly display in this direction the same enterprise and ability that has characterized its work in the other lines of engine building.

The Chicago Ship Building Company will build a large machine shop at its plant on the Calumet River, Chicago.

The Colorado Fuel and Iron Company, Pueblo, Colo., contemplates remodeling its mill and putting in considerable new machinery.

The Morgan Engineering Company, Alliance, O., have sold a 25-ton electric traveling crane of 50-foot span to the Midland Steel Company, Muncie, Ind.

The Chesapeake & Ohio Railroad Company has ordered 100 hopper bottom gondola coal cars of 40 tons' capacity each, of the Ensign Manufacturing Company, of Huntington, W. Va.

The Philadelphia Engineering Company, Philadelphia, Pa., has just completed a very large steel smoke stack for an electric light plant in Yokohama, Japan. The stack is 175 feet high, 7 feet 3 inches in diameter and weighs 95,000 pounds.

Edward P. Allis Company, of Milwaukee, Wis., has received a contract for a triple-expansion pumping engine of 30,000,000 gallons capacity for the Chestnut Hill Pumping Station, at Boston, Mass. The duty guaranteed is 150,000,000 foot pounds.

Notice is given by the parties in interest that all threatened litigation against the makers and users of the Wolhaupter arch and girder tie plate for infringement of the Servis tie plate patent has been settled. The Railroad Supply Company has accepted a license under the Servis patent, and has agreed to pay a royalty.

It is reports that the Dickson Manufacturing Company, of Scranton, Pa., has contracted for the erection of a large boiler shop for its locomotive works. The shop will be equipped with modern tools for making the heaviest of boilers, including power, cranes and a complete hydraulic and pneumatic plant.

The Sargent Company, Chicago, write us that in February they had the largest month's business ever experienced in their Sargent & Ross Meehan brake shoes, several railroads adopting the Sargent Shoe as their standard, while all their old customers ordered more freely than at any previous time. In their open-hearth department they are at work on one or two large contracts, and prospects point to soon reaching the maximum capacity of the plant. They have recently started up ther crucible furnaces and are now prepared to turn out work of any size or weight.

The Michigan-Peninsular Car Company, of Detroit, recently built for the firm of Mackie, Hussey & Company, at Barre, Vermont, a flat car of 100,000 pounds' capacity, to be used for the transportation of stone. The first load it carried was a large monument base 14 feet by 14 feet by 3 feet, with a hole 8 feet square through the center of it. The stone was carried on edge, and was lowered through a pocket in the floor of the car until it cleared the rails only 8 inches. The stone weighed 61,200 pounds. The car is 36 feet long, 9 feet 2 inches wide, and weighs 41,000 pounds without the blocking for securing the stone.

Henry R. Worthington, manufacturer of steam and electric pumping machinery, have recently received a contract from the Newport News Ship Building and Dry Dock Company, for the pumps for the United States battle-ships *Kearsarge*, *Kentucky* and *Illinois*. They are also building the pumps and pumping machinery for the United States battle-ship *Alabama*, now being constructed by the Wm. Cramp & Sons Ship and Engine Building Company. From the same firm they have received a contract for the pumps for the armored cruiser being built for the Japanese government.

The Empire Portland Cement Company, of Warners, N. Y., have issued a neat folder calling attention to the fact that their cement is being used by the government for the new dam at the government water power plant at Rock Island, Ill. The dam is entirely of concrete work. Special tests of the Empire cement were made in the Government Laboratory at the Rock Island Arsenal, Ill., in September, 1896, with the result that the tensile strength (seven-day test) was shown to be 534 pounds, neat; 213⅞ pound, for a mixture of three of cement of sand to one of cement, and 180 pounds for four of sand to one of cement, giving higher results than its seven competitors in the test. In making bids for furnishing a year's supply the Empire samples were submitted by various manufacturers and the Empire showed the greatest strength and the lowest ratio of cost to strength, viz.: .00345. The Western representative of the company is C. E. Schauffler, Resident Manager, Monadnock Block, Chicago.

Our Directory

OF OFFICIAL CHANGES IN MARCH.

We note the following changes of officers since our last issue. Information relative to such changes is solicited.

Alabama Great Southern.—The offices of General Superintendent, Chief Engineer, Superintendent of Motive Power, General Roadmaster and Superintendent of Bridges and Buildings have been abolished and these departments placed in control of Superintendent Wickersham.

Bloomsbury & Sullivan.—Mr. F. M. Leader has resigned as General Manager and the office is abolished. Mr. D. W. Campbell is appointed General Superintendent; office, Bloomsburg, Pa.

Buffalo, St. Mary's & Southwestern Railroad.—J. K. P. Hall has been elected Vice-President and Secretary.

Canabelle, Tallahassee & Georgia.—Master Mechanic S. A. Sheppard died March 11.

Canadian Pacific.—Mr. J. Spragge has been appointed Master Mechanic of the Atlantic Division. Headquarters, McAdam Junction, N. B.

Chicago, Rock Island & Pacific.—Mr. John Gill is appointed Master Mechanic of the Illinois Division, with headquarters in Chicago.

Columbus, Hocking Valley & Toledo.—Mr. Nicholas Monsarrat has been appointed Receiver. The office of General Manager is abolished. Mr. W. A. Mills is appointed Traffic Manager; office, Columbus, O.

Dominion Atlantic.—Mr. Wm. Grierson has resigned as Master Car Builder.

Fall Brook.—President Gen. George J. Magee died in Nice, France, on March 11.

Findlay, Fort Wayne & Western Railway.—B. W. Fenton has been appointed Chief Engineer, with office at Findlay, O.

Gainesville, Jefferson & Southern.—Mr. M. H. Dooly is Receiver.

Georgia & Alabama.—Mr. F. H. McGee has been appointed Master Mechanic, with office at Americus, Ga., vice J. E. Worswick, resigned.

Great Northern.—Mr. J. M. Barr has resigned the position of General Superintendent. Mr. Russell Harding succeeds him.

Hoxie, Pocahontas & Northern Railroad.—Maxwell Coffin is President and General Manager of this company, with office at Little Rock, Ark.

Lehigh Valley.—J. I. Kinsey is appointed Superintendent of Machinery. Mr. Philip Wallis is appointed Master Mechanic at Easton, Mr. Fred Roth at Delano, and Mr. H. D. Taylor Master Mechanic at Wilkes-Barre.

Lexington & Eastern.—Mr. J. D. Lewingston has resigned as Vice-President and General Manager. Mr. A. W. Barr is appointed General Manager and Mr. George Copeland Vice-President. Headquarters, Lexington, Ky.

Maricopa & Phœnix and Salt River Valley.—Roadmaster B. F. Porter will have charge of shops and car repairs, vice T. J. Morrison, resigned.

Minnesota & Wisconsin Railroad.—H. D. Burghardt is Purchasing Agent, with office at Spring Valley, Wis.

Missouri, Kansas & Texas.—Mr. Darius Miller has been elected Vice-President in charge of traffic.

Norfolk & Western.—Mr. James M. Barr has been elected Vice-President, with office at Roanoke, Va.

Philadelphia & Reading.—Mr. W. T. Gorrell, Assistant Master Car Builder, has been appointed Master Car Builder to succeed Mr. J. H. Rankin, promoted.

Pittsburgh, Bessemer & Lake Erie.—Mr. B. Gilbert has been appointed Master Mechanic, with office at Greenville, Pa.

Raleigh & Western Railway.—Murat Masterson has been elected Vice-President.

Seattle, Lake Shore & Eastern.—Receiver Thos. R. Brown died Feb. 2.

Southern California.—General Manager Kirtland H. Wade died suddenly March 11.

South Carolina & Georgia.—Mr. J. U. Jackson has been appointed Assistant to the General Manager. This road has leased the Augusta Southern.

Tennessee Midland.—Gen. J. C. Mann has been elected President, vice J. C. Clark, resigned.

Toledo, St. Louis & Kansas City.—C. B. McVay has been appointed Purchasing agent, with headquarters at Toledo, O.

Union Pacific.—Mr. D. Hickey has been appointed Division Master Mechanic, with office at Evanston, Wyo.

Wadley & Mt. Vernon.—Mr. G. A. Croft has been chosen Vice-President; headquarters, Atlanta, Ga.

Wheeling & Lake Erie Railway.—The office of Myron T. Herrick, Receiver, is at Cleveland, O. Robert Blickensderfer, Receiver is also General Manager, with office at Toledo, O.

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

MAY, 1897.

CONTENTS.

The United States Sea-Going Battleship "Iowa."

On April 7, 1897, the United States battleship *Iowa*, built for the government by the Cramps, of Philadelphia, was given a trial trip off the Massachusetts coast. The results were all that could be desired, and the contract speed of 16 knots was exceeded by more than a knot, the average speed developed during the four hours' trial being 17.087 knots.

The *Iowa* was built under an act of Congress approved July 19, 1892, and the contract was awarded the Cramps on Feb. 11, 1893. Her keel was laid Aug. 5, 1893, and she was launched March 28, 1896. It is the first in our navy of what are termed "sea-going" battleships, the *Indiana*, *Massachusetts* and *Oregon* being coast line ships The *Iowa* is somewhat larger than the *Indiana* and class, as will be seen from the following comparison:

	Indiana.	*Iowa.*
Length on load water line	348 ft.	360 ft.
Breadth of beam, extreme	69 ft. 3 in.	72 ft. 2½ in.
Displacement in tons, normal draught	10,288	11,110
Mean draught at normal displacement	21 ft.	24 ft.
Freeboard forward	11 ft. 7½ in.	19 ft.
Normal coal supply	400 tons	625 tons
Total coal capacity	1,640 tons.	1,780 tons.
Maximum indicated horse power contract	9,000	11,000
Speed in knots contract	15	16
Complement of officers and crew	460	486

The hull is of steel with a double bottom and close water-tight subdivisions extending up to a height of 10 feet above the load water line.

The formation of the sides amidship where they curve inboard secures the necessary freeboard without the added weight consequent to the lines being carried up with the water line fullness, gives an easier curve of stability, roomier quarters for the crew, greater sweep for the guns in the broadside sponsons, and promises efficiency of the great guns in almost any fighting condition of the sea.

For a distance of 185 feet 6 inches amipships the water line region is reinforced by a belt of 14-inch armor, 7½ feet wide, 3 feet above and 4½ feet below the water line. The forward and after ends of this belt turn inboard, and run diagonally across the ship with a thickness of 12 inches. Within the bounds of above armor and on level of its upper edge rests a flat protective deck of steel, 2¾ inches thick, and from the lower edges of the diagonal bulkheads, running forward and aft to the bow and stern, are two other protective decks, 3 inches thick, the forward one terminating immediately back of the ram.

From the top of the broadside belt and up to the line of the main deck running forward and aft amidships for a distance of 90 feet, the sides are 5 inches thick backed by a number of feet of coal. Forward and abaft the casemate armor from the protective deck up to the main deck, the outside plating is backed by a wide cofferdam filled with cellulose and divided into numerous compartments.

The main battery consists of four 12-inch breechloading rifles, mounted in pairs, in two Hichborn barbette turrets of the balanced type 15 inches thick, firing through an arc of 270 degrees, and eight 8-inch rifles in four barbette turrets 8 inches thick, mounted on the upper deck and firing through an arc of 160 degrees.

The secondary battery is composed of six 4-inch rapid-fire rifles four of which are mounted on the main deck in armored sponsons and sheltered by thick splinter bulkheads of steel, and the two remaining mounted aft on the bridge deck, sheltered by fixed shields. Twenty 6-pounder, four 1-pounder and four Gatling guns will constitute an auxiliary force, and be mounted on the main deck, on the upper deck and bridges, and in the tops of the military mast. The ship is fitted with 5 torpedo tubes, one in the stern and two in each broadside.

The propelling machinery consists af 3 double-ended boilers one 21 feet long, the other two 19 feet long, and two single ended boilers 9 feet 10½ inches long, all 16 feet 9 inches in diameter, placed in four water-tight compartments, and of two sets of triple-expansion engines, each in its own compartment. The total heating surface of the boilers is 23,950 square feet, and the total grate area 756 square feet. Each engine has cylinders 39, 55 and 85 inches in diameter by 48 inches stroke. The boilers supply steam at a working pressure of 160 pounds, and the engines are calculated to make 112 revolutions a minute. Under these conditions it was estimated that the ship would develop a speed of 16 knots an hour. With her bunkers filled and at a cruising speed of 10 knots an hour she should be able to steam about 8,022 miles, while at full speed under like conditions she should be able to cover 2,213 miles, and have an endurance of 5 days.

Nearly 100 auxiliary engines are installed for such purposes as turning the turrets, working and loading the guns, lifting and lowering the boats, raising the anchors, controlling the rudder, bringing up the ammunition from the magazines, providing fresh water, lighting the ship by electricity, making ice and preserving the fresh food, ventilating the ship, etc.

The conning tower is of steel 10 inches thick and through the armored tube leading below there is means of communication to every important station essential to control in action.

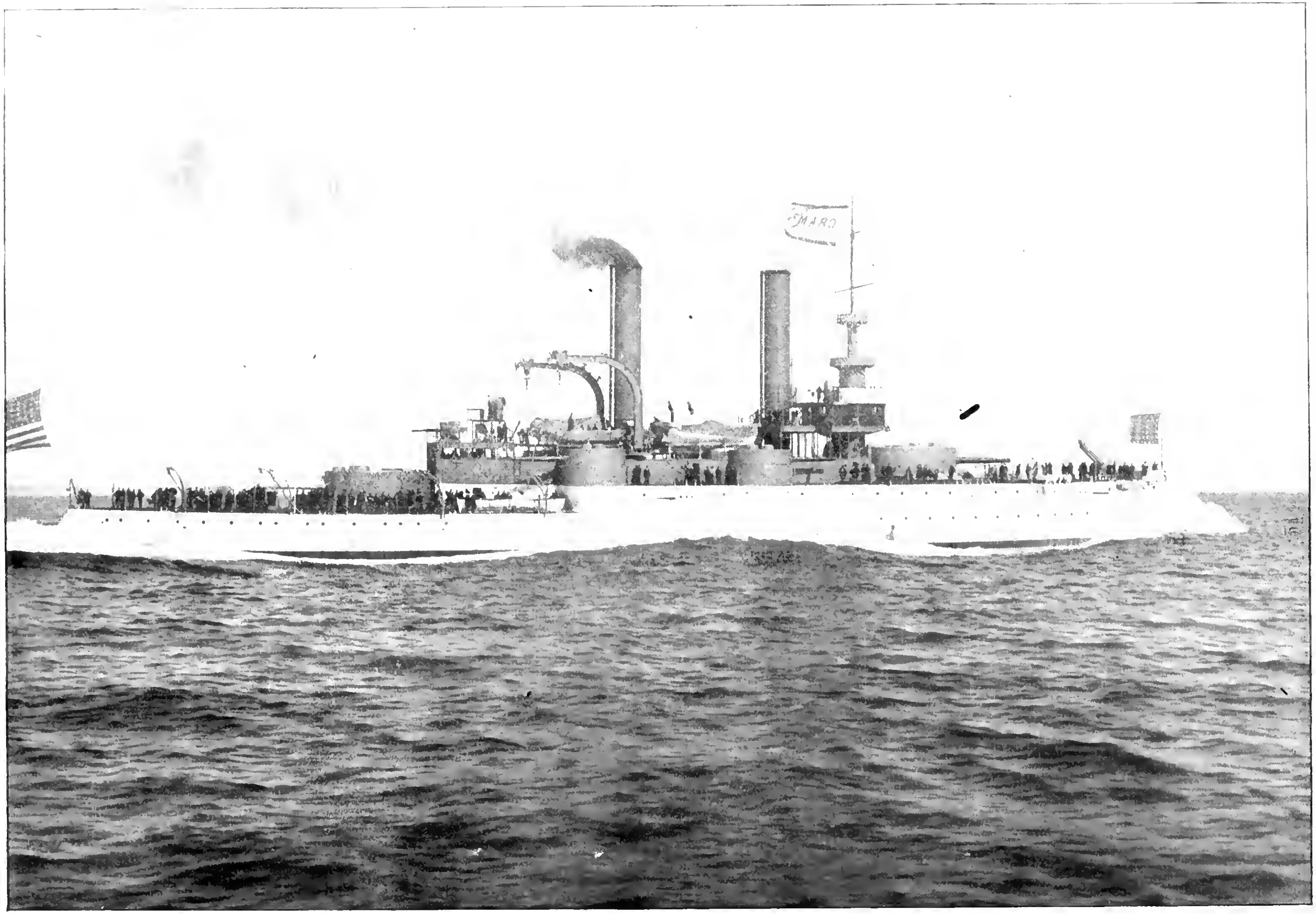
The use of wood has been dispensed with wherever possible, and the major part of that used has been subjected to an electrical fireproofing process of tried efficiency.

In armor distribution, scope of fire, possible speed, power of battery and sea-keeping properties the ship is claimed to be unexcelled abroad.

In regard to fittings to secure comfort for the officers and crew this ship does not differ materially from the coast line battleships save in one particular, but that an important one—the additional accommodation for the crew afforded by the forecastle deck. This is a very valuable feature.

The contract offered a bonus to the contractors at the rate of $50,000 for every quarter of a knot over the required 16 and the vessel thus earned a premium of $200,000 for her builders. This vessel is the last of those in which the builder gets any bonus for speed in excess of contract requirements.

On the trial trip the total indicated horse-power of the main engines was 11,834, the starboard engine making 108.61 revolutions and the port engine 110.51 revolutions per minute. The boiler pressure averaged 161 pounds. The total indicated horse-power of the main engines, including air, circulating and feed pumps, was 11,933.13 and the total indicated horse-power of all engines in operation during the trial was 12,104.8 horse-power. The speed, as already stated, was 17.087 knots.



THE UNITED STATES SEA-GOING BATTLESHIP IOWA ON HER TRIAL TRIP, APRIL 7, 1897.
Built by the WM. CRAMP & SONS SHIP AND ENGINE BUILDING COMPANY, Philadelphia, Pa.

The Cost of Operating Compressed Air Cars in New York City.*

The 125th street lioe of the Third Avenue Railroad has a length of 10,851 feet, making the round trip 4.11 miles, over which cable cars are operated at intervals of 2½ minutes. Air cars were substituted for two of these cable cars, the schedule calling for 19 round trips each, or 78.09 miles per car, or a daily service of 156.18 miles besides 1.14 miles of switching to and from the car-house and street tracks, making the total distance covered daily 157.32 miles. Each car runs from 12.50 to 16 67 miles on a single charge of air. The switching referred to is unavoidable in operating this service, owing to the arrangement of the car-house in relation to the street tracks, it being some distance from the terminal of the road.

During a portion of the time only single service was performed, as at present, so that the total average mileage per day from Aug. 3 to March 3 was 125.16 miles, and the total distance covered 23,030.5 miles, and the total number of passengers carried 137,386. The cars have been operated every week day, but are not run Sundays.

In the following statement of operating expenses, the coal and water items include all that has been used at the compressing plant during this period, and the labor account includes, in addition to the operating employees, a night watchman, record keeper, and also switchman for a portion of the time. It must also be borne in mind that the fires are kept under boilers for 24 hours, although the compressor runs only 7 hours daily.

Actual average cost per car-mile for entire period—7 months—125.16 miles per day:

Coal	$0.056
Water	.010
Oil and waste	.001
Power plant labor	.126
Conductor and motorman	.060
Repairs car equipment	.003
	$0.2586

Average present cost per car-mile, while one car service performed—78.09 miles per day:

Coal	$0.0675
Water	.0113
Oil and waste	.0017
Power plant labor	.0883
Conductor and motorman	.0608
Repairs, car equipment	.0038
	$0.2284

Average present cost per car-mile with two car service—156.18 miles per day:

Coal	$0.0433
Water	.0103
Oil and waste	.0013
Power plant labor	.0833
Conductor and motorman	.0608
Repairs	.0028
	$0 2018

If the proportion of labor actually utilized in this service is considered, the expense would only amouot to $0.1791 per car-mile at present.

Present number of employees is six, besiders conductors and motormen.

The reason for the present cost of operation being lower than the average for entire period is that the number of employees has been reduced, in addition to a less air consumption by the car. The number of employees at present is, however, sufficient to operate a 15-car service, so that the proportion of labor charges per car-mile is still very high.

At a recent conference of several engineers, who investigated the cost of operating the American Air Power Company's system in behalf of a street railroad now operating a large number of cars at intervals of one minute, it was determined after careful examination, and agreed that for the items above enumerated the cost per car-mile would in no event exceed $0.085, and that with a large equipment of cars in service, like that performed on 125th street, the cost would only be $0.0756 for the same items now costing 0.2018, while operating the two-car service. This would make the total operating expense of such a road about 12 cents per car mile.

In the recently published report of the operating expenses of 22 electric roads in Connecticut for 1896, the West Shore Street Railway Company, West Haven, is reported as operating precisely the same mileage, namely 411, with the same number of cars in service, having, however, only five employees, and the average cost of operation per car-mile is shown as $0.2991.

In the published report referred to, the average cost of operation per car-mile of the 22 roads given is $0.1444, and in the 20 roads having the items of motive power and line repairs given, the average cost appears as follows:

Motive power, average	$0.02816
Line	.00270
	$0.03086

The average consumption of free air per car mile for the seven months' service of air cars on 125th street has been 4.77.7 cubic feet. During the last week the average consumption of free air per car-mile was only 414 cubic feet, and many of the trips were made on considerably less than 400 cubic feet. Assuming the average consumption of air per car-mile can be be kept as low as at the present time, the average cost of motive power per car-mile would range from $0.0121 to $0.027, or an average of $0.0197, and even if 477.7 cubic feet, the same as averaged for the past seven months in regular service, the cost per motive power per car-mile will range from $0.014 to $0.032, or an average of $0.023.

At the 125th street compressing plant the engine is operated only about seven hours daily, while the cars perform a 12-hour service from a 7-hour station duty.

* From a letter by Mr. E. E. Pettee, Engineer for the American Air Power Co., to Compressed Air.

Specifications for Malleable Iron Castings.*

The rapid growth of the use of malleable iron castings in car and locomotive constructioo has been brought about principally through constant and material reductions in their selliog cost; the former great difference in cost between gray and malleable iron castings has largely diaappeared. There is still an average difference of about one and one-quarter cents per pound, but this difference quite disappears in the net costs, a malleable casting of a given pattern weighing sometimes 60 per cent. less than the corresponding gray iron casting. This great slump in malleable iron prices has benefited the purchasers at the expense of the manufacturers. It is true that increased and improved facilities have cheapened the cost of production, and the stronger companies have been able to buy raw materials at lower prices. But there is a danger now that purchasers will be made to suffer unless they protect themselves by rigid requirements as to quality.

In the making of good gray iron castings there is a greater latitude in the selection of pig and scrap and of mixtnres, than in making malleable iron castings. In making malleable iron castings greater care is necessary in melting, molding and rapping. As they contract in cooling after molding nearly ¼ inch in one foot, and as they expand in annealing ⅛ inch in one foot, two movements are given to the molecules of iron, and this must be taken into consideration all through the process of manufacture, from the selection of the different kinds and grades of pig and scrap, through the mixtures, meltiog, molding, packing and annealing; and particular care is required in making patterns to distribute the metal in as nearly as possible uniform masses.

In cleaning by tumbling, or otherwise, greater care is required than with gray iron castings because the heat of annealing "burns on" any sand not removed in cleaning. This is a serious matter if the castings are intended to fit over other parts and in castings which must be galvanized, because the zinc does not deposit upon the sand. Pickling does not always remove the "burnt on" sand. As dependence is placed not altogether, but largely, upon the "skin" of malleable castings, the cross-section at any point should be such as to give as much outside surface as possible.

In submitting these specifications it is not expected that they will be accepted as complete or free from flaws. It is hoped that discussion will follow with the object of producing a set of specifications under which malleable castings, for railroad uses particularly may be purchased and thus avoid the evils to which reference has been made. It is not thought well to control the manufacturers in way but in the results, unless it might be, in selecting whether the iron shall be cupola or air-furnace melted.

The practice that is followed in gray-iron work in casting a test piece in the same mold with the casting proper can hardly be followed in getting malleable iron test pieces. The condition of gray iron castings is supposed to be uniform throughout a given casting or in any number of castings from a variety of patterns representing thick and thin sections, while in malleable castings the annealing is most effective on thin sections. Therefore, a solid test piece of malleable iron would hardly represent a lot of malleable castings

* From a paper by C. L. Sullivan, read before the Western Railway Club.

from a variety of patterns. These are the principal reasons for recommending that test pieces shall be taken out of a finished casting, one or more pieces from different castings (patterns) to be taken at the option of the inspector.

In 1891 and 1892 a committee of the Master Car Builders' Association reported the results of some tests on specimens of malleable iron castings. The finding of the committee was for a tensile strength of from 25,000 to 34,000 pounds per square inch. Since then a considerable advance has been made and we are justified in expecting better things. The figures for tensile strength that I will recommend are not as high as one manufacturer has expressed a willingness and ability to guarantee. The specifications submitted for discussion and possible revision are as follows:

TENSILE REQUIREMENTS.

At the opinion of the inspector, one, two or three castings of either one or different patterns shall be selected from each 2,000 pounds of finished product. From one or all of the castings thus selected test pieces shall be cut and prepared, one from each selected casting. The position in the casting from which the test piece shall be cut is to be determined by the inspector. The size of the test piece shall be, as nearly as possible, such as will give, when the piece is prepared, a uniform clear length of 4 inches between the grips of the testing machine, and such as will give as nearly as possible a cross-section area of one-half square inch. Tests of one or each of the pieces thus prepared shall show a tensile strength of not less than 40,000 pounds, and not more than 47,000 pounds per square inch. The elongation and reduction of area measured after fracture shall be distinctly noticeable as indicating some degree of ductility and should be at least 1.5 per cent. for each. Should the average of three tests show a tensile strength below 43,000 pounds; and coupled with this, if ductility is not plainly discernible, the inspector shall have the option of repeating the test.

TRANSVERSE REQUIREMENTS.

Besides the tensile tests, transverse tests shall be made as follows From the same castings or others at the opposition of the inspector, one, two or three test pieces shall be prepared, giving a length of 12 inches between centers of supports and having as nearly as possible a cross-section of 1 inch square. If there should be any difference in the dimensions of the sides, the piece should be set in the machine with the greater dimension vertical.

The supports shall be 12 inches apart, center to center, and of the usual shape for making transverse tests of gray-iron castings. Tests of one or each of the test pieces thus prepared shall show an ultimate transverse strength of from 3,900 to 4,800 pounds per square inch, and deflections from 0.35 to 0.65 inch. The average breaking load for any number of tests should be about 4,300 pounds per square inch and the average deflection about 0.5 of an inch: this for specimens of the sizes recommended and for a metal of the characteristics suitable for car castings.

The fractures in both tensile and transverse tests should be fine grained and uniform; blow holes should be absent; bright edges like the chill in chilled castings should generally show distinctly at the edges; the center should generally appear almost as dark as burnt iron. No great dependence, however, can be put upon an examination of the fracture in determining the quality of malleable castings, further than seeing that castings are of uniform fine grain and free from blow holes, as the fracture will vary in appearance according to the size of section.

BENDING AND TORSIONAL TESTS.

Malleable castings which successfully pass the above requirements in tensile and transverse tests will generally successfully pass bending and torsional tests of equivalent severity. Reasonably thin sections, about $\frac{3}{16}$ to $\frac{9}{16}$ inch thick by about 1 to 3 inches wide, should bend over on themselves around a circle at the bend equal in diameter to twice the thickness of the piece and back again straight. And in torsion a thin piece of uniform dimensions, or nearly so, should twist once around without fracture. It only require proper mixtures and proper annealing, coupled with care in other particulars, to make malleable castings that will weld on themselves; that will draw out to a knife edge on an anvil under a hammer; that will temper and cut soft iron like a cold chisel. Such castings, however, cannot be had at the prices at which some malleable castings are quoted, and probably such qualities are not required in car castings.

Tests for Steel Tubes for Thornycroft Water Tube Boilers.

The specifications for the steel tubes used in the construction of Thornycroft water tube boilers have been furnished the Journal of the American Society of Naval Engineers, by Mr. John Platt, of New York, the agent in this country for Messrs. Thornycroft & Company, from which publication we take the following:

Tests for Boiler Tubes.—The boiler tubes are to be solid drawn, finished cold, so as to remove all traces of the hot process, and leave perfectly smooth surfaces inside and outside.

The tubes are to be perfectly straight, smooth, cylindrical, of uniform sectional thickness, and of equal diameter throughout, excepting as specified below; they are to be free from any scale, longitudinal seaming, grooving or blistering, either internally or externally, and they are not to be oiled, varnished or painted.

The ends of the tubes are to be pressed or squeezed up for screwing in a die or press (not by hammering or upsetting). Any case discovered of a strip being welded on will render the whole liable to rejection. The tubes are to be made from acid or basic open-hearth steel, which material is to stand the following tests:

	Ultimate tensile strength.		Elongation in a length of 2 inches, per cent.
	Not more than, tons.*	Not less than, tons.*	
(a) Annealed pieces cut from the forging from which the tubes are to be made	24	21	33
(b) Annealed pieces cut from the tubes...	26	..	27

*Tons of 2,240 pounds.

Test (a) is to be carried out at the works of the tube maker, and (b) at the works of the makers of the boilers.

Strips cut from the tubes, flattened, heated to a blood heat, and plunged into water 82 degrees Fahrenheit temperature, should be capable of being doubled over a radius of ½ inch without fracture. This test is to be carried out at the works of the makers of the boilers. Pieces 2 inches long, cut from the tubes under $\frac{3}{16}$ inch thick, are to be capable, when cold, of being hammered down lengthwise until their length is reduced to 1 inch. The tubes themselves are to be capable of being flattened by hammering at any part until the sides are close together, for tubes under $\frac{3}{16}$ inch thick and for tubes $\frac{3}{16}$ inch thick and over the sides are to be brought to a distance apart of twice the thickness of the material of tubes, in each case without fracture. The ends of the tubes under $\frac{3}{16}$ inch thick are to admit of being expanded cold by a three-roller expander, worked in a series of three tube holes, and hot by a solid drift to the following increases of diameter:

With roller expander fitted with three rollers (cold), 12.5 per cent.; with solid drift (hot), 20 per cent.

Tubes $\frac{3}{16}$ inch in thickness and over are to admit of being expanded hot and cold to half the increase in diameter required for the tubes under $\frac{3}{16}$ inch.

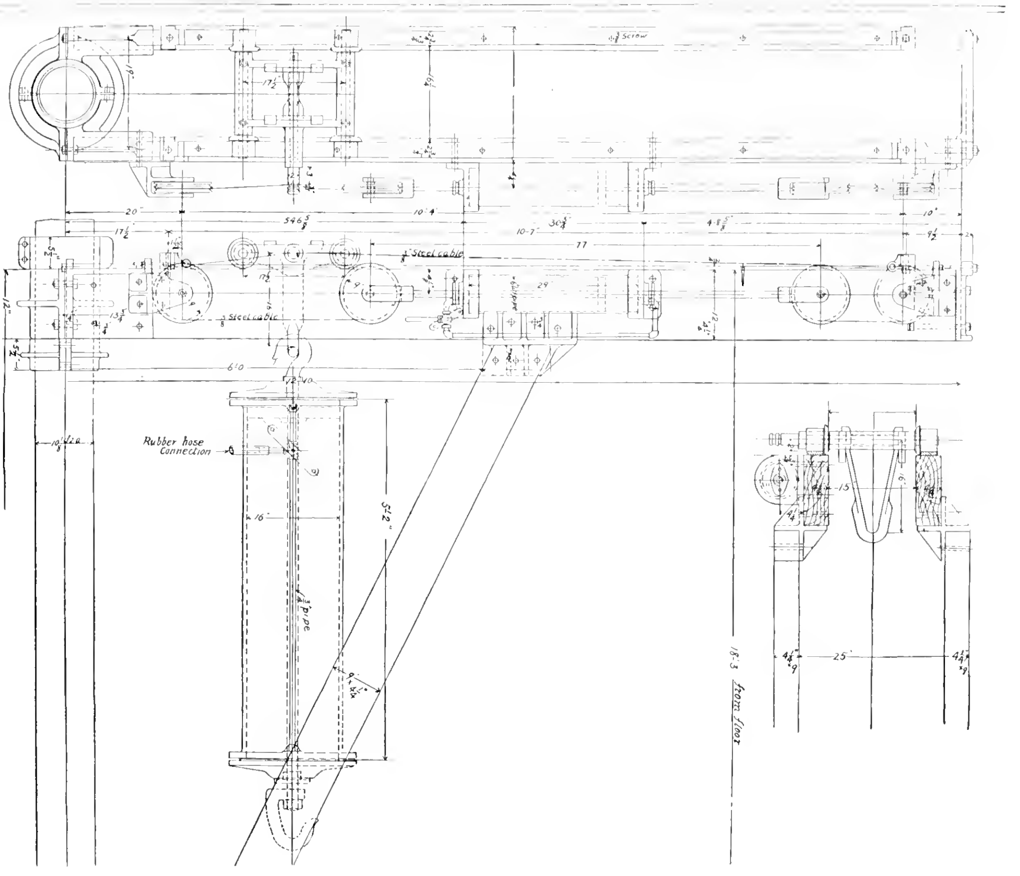
The above tests are to be carried out at the works of the makers of the boilers, and are to be applied to two per cent. of the tubes, to be selected by the examining officers, after electric galvanizing; and these tubes are to be completely destroyed for the purpose of this test. The tubes for this purpose are to be arranged in parcels of 100, and all rejected tubes are to be marked by the examining officers, so that they may be capable of identification. The failure of the tubes selected will reject the parcel of 100 from which they were taken.

Each tube must stand a test by water pressure internally of 1,500 pounds per square inch, after bending and annealing, but before electro-galvanizing, without the slightest indication of weeping. This test to be carried out at the boiler makers' works.

The failure of a large proportion of the tubes selected to stand any of the above tests in a satisfactory manner will render the whole of any delivery liable to rejection.

All tubes are to be thoroughly pickled to remove scale, and unless otherwise ordered are to be galvanized externally by electro-deposition. Each tube is to be removed from the electro-depositing bath after being immersed and subjected to the electro-depositing action for about 15 to 20 minutes. It is then to be carefully examined, and, if any defects are exhibited, the tube is to be rejected. The satisfactory tubes are to be replaced in the bath and coated with zinc to an extent of 1¼ ounces per square foot galvanized surface.

The limit of variation of weight of each tubb which will be allowed is 2½ per cent. above the weight calculated from the approved dimensions, allowing 480 pounds per cubic foot of metal. All tubes exceeding this limit, or less than the specified thickness, will be liable to rejection. All tubes which are less than the external diameter specified, or more than 1 per cent. larger than the diameter approved, will be rejected.



Pneumatic Crane for Wheel Press.—Chicago, Rock Island & Pacific Railway.

Pneumatic Crane for Wheel Press—Chicago, Rock Island & Pacific Railway.

In the accompanying engraving we illustrate a pneumatic crane recently erected over a large wheel press at the Chicago shops of the Chicago, Rock Island & Pacific Railway, the drawings being furnished us through the kindness of Mr. Geo. F. Wilson, Superintendent of Motive Power. In designing this crane the motive power department was much handicapped by the conditions in the shop, particularly in the small amount of head-room, the effect of which is seen in the construction of the trolley or carriage. The lifting of the load is accomplished by a 6-inch cylinder hung from the trolley and with a hose connection and operating valve of the usual construction for shop lifts.

The movement of the trolley horizontally by air was in the nature of an experiment. A 6-inch cylinder, double acting, was applied as shown, and by means of ⅝-inch steel rope passing over fixed sheaves hauled the trolley either direction, as desired. The pull on the carriage was calculated at 700 pounds, but it was found that the trolley could be moved only when the load suspended for it did not exceed 3,000 pounds. Subsequently an 8-inch cylinder, similar to the 6-inch one shown, was placed on the other side of the crane, and connected to the trolley in the same manner as the first one. With the two cylinders the trolley can be operated when the load suspended is as great as 10,000 pounds. The need of so much power is, in part at least, to be attributed to the small wheels on the trolley. They are only 4 inches in diameter, and have 1½-inch axles. If there were room for larger wheels the friction would undoubtedly be much less.

With the air cylinders as now applied the load can readily be moved; but there remains one difficulty which is common to many uses of compressed air. The friction of the trolley at rest is so much greater than when it is moving, that after it is once started the force of the expanding air in the cylinders causes the carriage to move a greater distance than may be wanted—that is, if the desired movement is small, and a movement of, say ¼ inch, is almost impossible to get. Hydraulic lifts of a like construction do not have this objectionable feature, as the water is practically non-expansive, and the piston does not move more than what is due to the volume of water let in. It would seem as if in such cases as this the whole difficulty would be overcome by using water in the cylinder, and air back of the water to furnish the pressure. Such a construction would not be difficult. The present construction, however, works very nicely in all but the very small movements.

It is intended to fit to this crane an air cylinder for swinging it, and then all operations will be performed by air. This cylinder will be located on the under side of the horizontal arm of the crane, and will have a double-acting piston, carrying a sheave at each end of the piston-rod. A wire rope, having each end fastened to the crane, will pass over the sheaves and make a number of turns around the pillar of the crane. Thus the crane will be swung in either direction, and as all operating valves for the three movements of the crane can be grouped together, the arrangement is a most convenient one.

An Automatic Weighing Machine with Power Feed.—Built by The Pratt & Whitney Co.

The field for an accurate and reliable automatic weighing machine of such a design as to permit of its construction in any desired capacity, is so great as to be almost beyond belief. That this field has not been more fully occupied by some of the automatic machines brought out in the past has been due to the fact that the machines have been defective in some respects, and not that there was any lack of purchasers for a satisfactory device. As an illustration of the wide diversity of uses to which reliable machines are being put we would cite their use by grocers in weighing sugar and such materials into bags, their use in weighing breakfast cereals, etc., into boxes and packages, and the weighing of grain at the mills, while in manufacturing establishments, where the accurate mixture of several materials is needed to produce a desired result, automatic machines are used to great advantage. An illustration of this is in the manufacture of cement, and in cases where several materials are to be mixed the necessary number of machines are placed side by side and arranged to work in unison, each machine weighing its proper share of the mixture. Then these machines are useful in weighing cottonseed, cottonseed meal, salt, fertilizers, broken ores and coal. They are employed to check the weights of coal received and also to ascertain the amount consumed daily in steam generation or in other ways about an establishment. Other uses might be mentioned, but these suffice to show the range of these machines.

Undoubtedly the most practical of the automatic weighing machines on the market is that built by The Pratt & Whitney Company, of Hartford, Conn., from the designs and inventions of Mr. F. H. Richards. This well-known firm has brought its energies and mechanical talent to bear upon the improvement and perfection of the machine, and now after several years of effort and the expenditure of thousands of dollars it has brought the machine up to a high standard of excellence, and is making them in sizes ranging from 2 pounds to 2,000 pounds bucket capacity. Through the courtesy of Mr. Geo. W. M. Reed, Second Vice-President and General Manager of the company, we have received the drawings from which the accompanying engravings have been made.

To those of our readers who have seen or are familiar with the weighing machines in which the bucket has considerable movement of one kind or another, such as swinging downward or tipping when full, the construction of the machine we illustrate embodies a much more attractive principle of operation and one that from a mechanical standpoint will appeal to everyone capable of appreciating excellence of design. In Figs. 1, 2, 3 and 4 we show a side elevation, two end views and a plan of a machine of 600 pounds or 10 bushels capacity, and in Figs. 5, 6, 7, 8 and 9 we give various views of an excellent counter used on the machine and also placed on the market separately by the company.

The bucket *A* in which the material is weighed is a rectangular affair with a drop bottom, and in this size of machine is 44¼ inches long, 24$\frac{3}{16}$ wide and 35 inches deep. It is maintained in an exactly vertical position at all times, and is supported by four knife edges upon the levers or weighing beams *B B*, which in turn are fulcrumed upon other knife edges on the base of the machine. These weighing beams consist of two round bars of iron extending the length of the machine, one in front of the bucket and the other behind it, with their ends turned inwardly to form weighing levers. Each piece is supported by two knife edges on the base and is limited in downward movement when the bucket is emptied by brackets, also on the base, as seen in Figs. 1 and 3. These weighing beams are designed to balance the weight of the bucket and its load, and the sliding weight seen in Fig. 3 permits of final and accurate adjustment after the machine is put together.

The material to be weighed enters the hopper *C* and falls upon a conveyor *D* composed of a pair of drive chains and a series of overlapping slats, pivoted at one edge to the chains. On the upper side of the conveyor the slats are closed, but as they pass to the under side they open by gravity as shown, so that all material falls from them. This conveyor is driven by worm gearing *G* (Figs. 2 and 3), the power being supplied from a belt running on pulleys *E* and *F* (Fig. 4). Just above the worm gear is an arrangement of spur gears, not unlike the back gears of a lathe, by which two speeds are obtained. The pulley *E* is tight on the shaft and drives the worm direct. It runs at a speed of 400 revolutions and feeds the load into the bucket at a rapid rate until over 80 per cent. of the bucket capacity has been reached, when the belt shifts to the pulley *F*, which then drives the conveyor at a reduced speed by means of the back gears and a ratchet in the gear *I*, until the bucket has been fully loaded when the belt is shifted to the loose pulley and the feeding stops, until the bucket is emptied and ready for another load. The eccentric *H* works a shaker provided with fingers, which play over the slats at the point where they deliver their load. This operates only when the conveyor is running at the slower speed. The conveyor or power feed is only employed when materials that will not flow freely are to be handled.

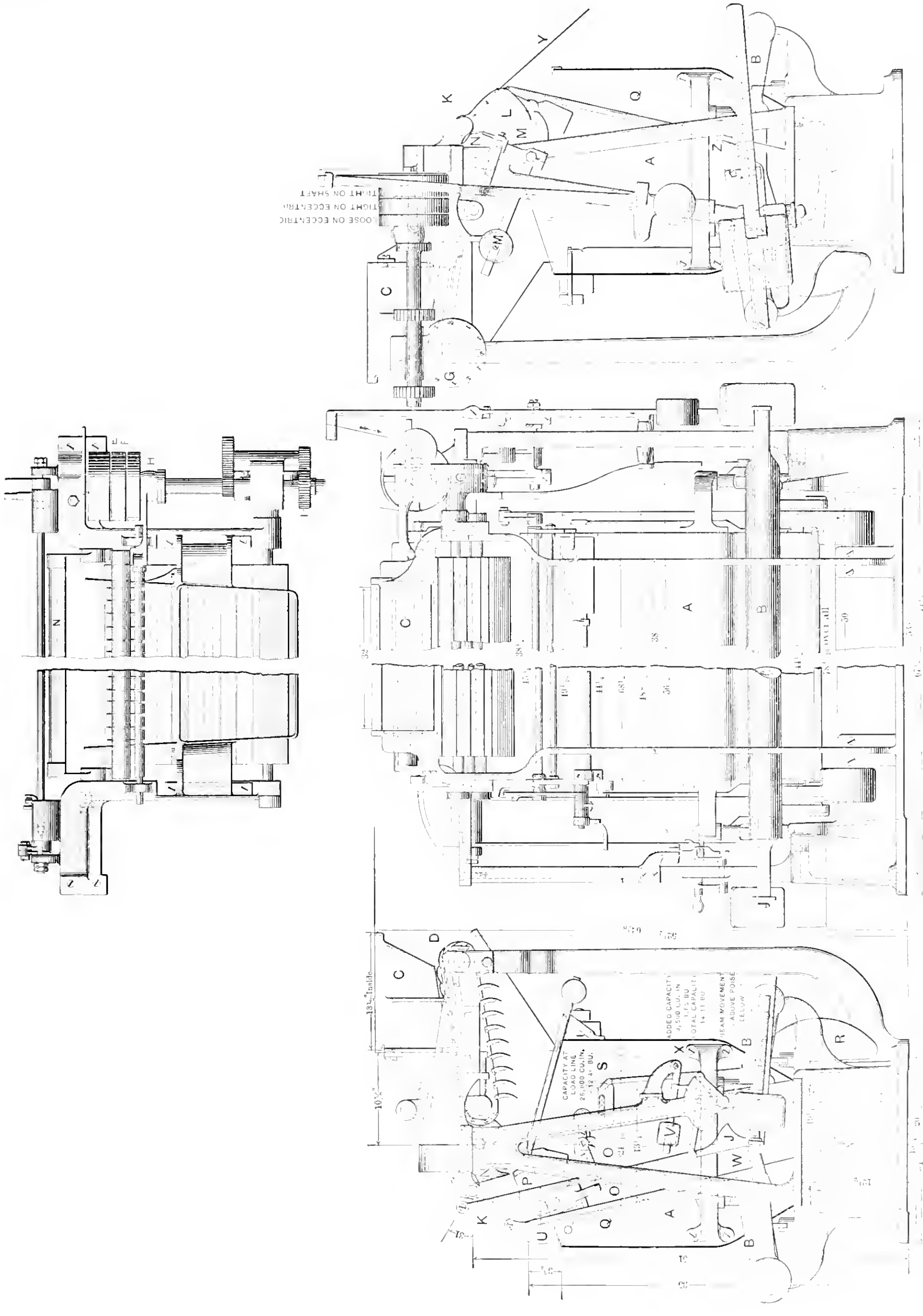
All the movements of the various parts of the machine are controlled by the small vertical movement of the bucket upon the weighing beams. In order to explain the functions of the various parts we will assume that the bucket is being filled at full speed, at which time all the parts are in the positions shown.

When the bucket has received the larger part of its load, the weight of this partial load, together with the action of the weight *M*-1 (through lever *M*, cam *L*, shaft *K* and valve rod *J*) operates to bear down the beam arm, thus carrying the bucket downward a portion of its stroke, and thereby shifting the driving belt on to the slow speed pulley *F*, thus reducing the conveyor speed and delivering the material in a small stream, and thereby obtaining a nice balance. The valve *N* is also partially dropped. (This valve is seen in Figs. 1, 3 and 4, and is for the purpose of catching the material that is in the act of dropping when the bucket is full.)

During this period of the loading operation the long arm *Y*, called the drip lever, rests against the drip-lever latch *Z*, carried on the extended arm of one of the beams, so as to have a relatively downward movement, as compared with the bucket. When the bucket load is completed, lowering the bucket very slightly, the latch *Z* is carried below the arm *Y*, thus permitting the weighted lever *M*, operating through its connections, to suddenly close the cut-off valve under the forward end of the conveyor. This instantly catches the last part of the drip stream, preventing it from going into the bucket. The same operation shifts the driving belt from the slow-speed pulley to the idle pulley *R*, and thus entirely stops for the moment the operation of the conveyor.

The rod *J* in dropping also forces down the catch *O* which holds the cam *P* (Fg. 1), and as the interlocking cam *T* is now out of the way, the shaft *U* is free to rotate, and the rods *QQ'* no longer hold the drop bottom in position. Hence it opens and discharges the load through the base of the machine. At the moment the load falls, not a part of the machine is moving except the belt on the loose pulley of the conveyor. The load once out the counterweight on the drop-bottom closes it, returning the cam *P* (Fig. 1) to the position shown. Of course the weighing levers raise the bucket at once, but until the drop door is closed tightly the machine cannot start, for until then the cam *P*, by blocking the cam *T*, prevents the shaft *K* from rotating. As soon as the bottom is closed the cam *T* is liberated and the shaft *K* is rotated by the rod *J*, which is forced up by the weighted lever *W*. By this movement the valve *N* swings up and drops into the bucket the material caught by it, the shipper throws the belt to the position in our illustration, and the bucket begins to fill again.

It is apparent that when the valve *N* drops to catch such material as falls from the conveyor after the full load has depressed the bucket, it cuts into a falling column of the material, and that portion in the air and below the valve falls into the hopper. One of the important refinements of this machine is an arrangement to compensate for this small quantity that falls into



THE RICHARDS AUTOMATIC WEIGHING MACHINE WITH POWER FEED.
Built by the Pratt & Whitney Company, Hartford, Conn.

the bucket after it is poised. A small weight V is adjustable on a lever fulcrumed upon the frame of the machine and connected to the bucket mechanism. It is adjusted by trial to exert a downward pressure on the bucket sufficient to make the latter operate the scale while the weight in the bucket is short of the full amount by that quantity that is falling.

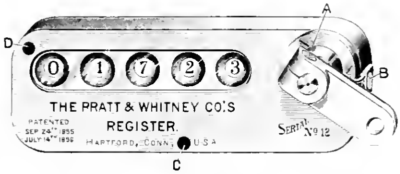


Fig. 5.—The Pratt & Whitney Counter.

The accuracy of the machine may be tested at any time by throwing some of the automatic mechanism out of gear in the following manner: The crank X (Fig. 1), fulcrumed on the frame, operates a rock shaft having a connection with the rod J. By moving this crank about one-eighth of its travel, the rod J is shifted far enough to be disengaged from the catch O, so that though the machine takes its full load the bucket cannot empty. The crank X is then moved far enough to throw the rod entirely out of contact with the scale mechanism, while at the same time the weight V is also lifted from the scale. Thus the load-weighing mechanism supports the bucket free of all obstructions, and is

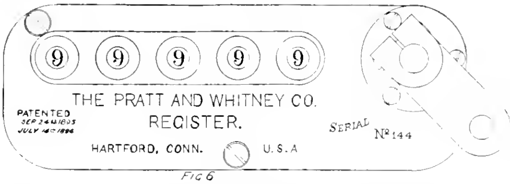


FIG 6

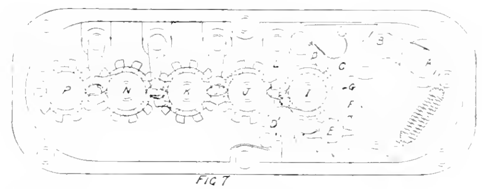


FIG 7

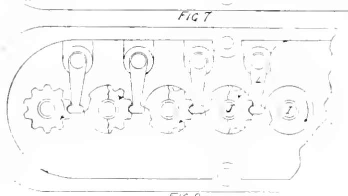


FIG 8

FIG. 9.

The Pratt & Whitney Counter.

free to oscillate through its entire working stroke. The operator can thus at any time satisfy himself of the accuracy of the adjustment of the machine.

The machine is provided with two Counters, operated by the movement of the drop bottom, one of which is seen in Fig. 1 and the other in Fig. 2. That seen in Fig. 1 is such a perfect device that it needs no check of any kind, but the second is one that can be set to stop the machine after a certain number of weighings. This it accomplishes by throwing a catch into contact with the cam P (Fig. 1), thus stopping the machine.

The first mentioned counter is one that originated with the company and has been perfected until it is believed by them to be one of the finest on the market, and they find a ready sale for it for many purposes. Figs. 5 and 6 are exterior views of the counter, and Figs. 7, 8 and 9 show its construction. The operating crank is attached to the shaft A, which carries a lever provided with a roll B engaging with the pallet C. This carries a spring pawl D which drives the toothed wheel on the shaft I. Another spring pawl D^1 prevents a backward motion of the wheel. The latter pawl is composed of three superimposed plates of three lengths varying from each other by $\frac{1}{100}$ of an inch, so that one, two or all three may drop into position behind a tooth and the backlash thus be kept down to a minimum. It will be noticed that the pallet also carries the escapements G and H operating in conjunction with the toothed wheel E which also meshes with I. This more refined mechanism does not come into play unless the pawls DD^1 should for some reason become inoperative. When those pawls are working, the escapement only drives the wheel E, and is practically without wear or strain. The roll F at the end of a spring-actuated lever prevents overthrow.

There are five dials, and each spindle, I, J, K, N and P, carries a spur wheel of 10 teeth, and all but P carries a driver with one tooth, so that 10 revolutions of the units dial causes one revolution of the tens, etc. Each of the spindles J, K, N and P is also provided with an ingenious locking mechanism that is simplicity itself. It consists of a disk with one notch in its circumference, as shown on spindle I in Fig. 8, and in the same plane on the next higher spindle, J, is a disk with 10 notches. Between the two is the T-shaped end of a lever, L, fulcrumed at the side of the case. During nine-tenths of a revolution of I the disk on it keeps the spindles J locked, as shown, but during the last tenth of the revolution, when it is necessary that J should move also, the notch arrives opposite the end of the lever and J is released. Each spindle is thus locked at all times when it should be stationary.

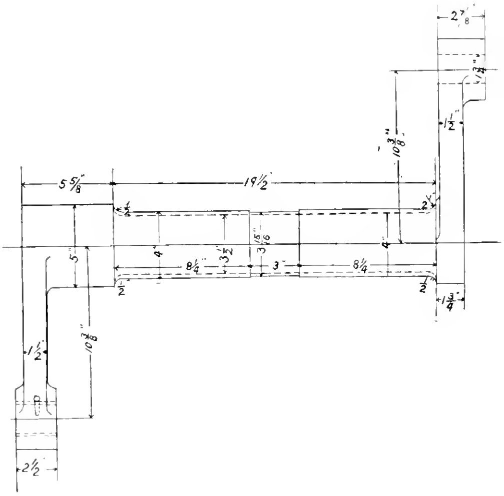
The counter is of special interest as an instrument of precision. It is manufactured on the "interchangeable system," by a plant constructed especially for it, and made by the most approved methods of watch-tool manufacture. The working parts are contained within a plain but neat and substantial case—positively excluding all dust and protecting the works against all ordinary accidents. This instrument was produced primarily for use on the automatic weighing machines. An experience of two years or more having demonstrated the practicability of the instrument, the company has adopted it for its own use, and has offered it to the trade, believing that its merits will be appreciated by all who require a reliable count of the movements of any class of machines.

Fort Wayne Notes.

At the Fort Wayne shops of the Pittsburg, Fort Wayne & Chicago R. R., Mr. G. L. Potter, Superintendent of Motive Power, has greatly reduced the wear of certain parts of locomotives by the use of bronze cast on to the parts whose wear is excessive. Engine truck wheel hubs are so treated, and with excellent results, particularly where the wheel centers are of wrought iron. The inside hub is faced and turned to a dove-tail section, after which the wheel is taken to the foundry and the bronze facing cast on. The diameter of the bronze face is purposely made much larger than the original hub, the size usually being about 12 inches, and a large wearing surface of excellent material thus obtained.

Other parts of the locomotive treated in much the same fashion are the eccentrics. These are rough-turned about one-half inch smaller in diameter than the eccentric straps, and of such a form as to hold the bronze firmly in place. A shell of bronze is then cast on each half of the eccentric and afterward turned off to fit the strap. There have been no hot eccentrics on engines so fitted, and furthermore the repairs are easily made, as lost motion can be taken up by casting a new bronze shell on the eccentric.

With the large valves so common in modern locomotives it has been found that the rockers and boxes wear rapidly, and when the boxes are babbitted the metal is liable to be squeezed out of shape. A bronze sleeve is therefore cast on the rocker shaft, as shown in the accompanying cut, and the journal and box now wear so well that an engine goes through the shops several times before wear is taken up. When this is done the box is simply bored out true, a new sleeve cast on the rocker shaft and turned to fit the box.



Rock Shaft with Bronze Bushing Cast on It.

This method of casting the bronze on to the part to be protected by it is found to be much cheaper in first cost and repairs than any other method, the labor item being very small. In the foundry special flasks are used and before casting the part to which the bronze is to be applied is warmed to a temperature of, say, 450 or 500 degrees.

It is probable that few persons have realized that the maximum pressure upon the front side of a driving box is much greater than upon the back side when the engine is going forward. And yet such is the case, for when the piston is moving forward the pressure upon the front of the box is equal to the sum of the pressure on the crank pin and the tractive effort of that wheel at the rail, and when the piston is moving backward the pressure is on the back of the box and is equal to the difference between these two forces. This fact was forcibly demonstrated at Fort Wayne recently in the case of some engines whose driving box linings were not extended down to the center of the journal, but were shortened about one inch with the hope that if they got hot they would cling to the journal much less than usual. It was found that these brasses had a marked tendency to wear toward the front, and in seeking for the reason the reason the difference in pressure front and back was noted. Further investigation has also disclosed the fact that the breakages of the driving boxes are in general more numerous on the front than the rear side.

Two of the class O eight-wheeled engines, with 18-inch cylinders, have recently been fitted with the form of exhaust pipes and nozzles recommended by the committee of the Master Mechanics' Association, and with excellent results. Where 4¼ or 4½ nozzles were formerly used, a 5-inch nozzle is now employed and the steaming qualities are improved. One of these engines recently hauled a train of ten cars, three of which were Pullman sleepers, over the division between Chicago and Fort Wayne, 148 miles, and made up 31 minutes on a schedule of 4½ hours—a remarkable performance.

Some Possibilities of Power Generation by Gas Engines and the Utilization of Rejected Heat.*

BY REID T. STEWART.

It will be my purpose to-night to present for your consideration, with the hope of stimulating general discussion, some of the possibilities of power generation by means of the internal combustion engine. Engines of this type have been proposed to run upon almost every conceivable cycle and to consume almost every available fuel. Very few of the numerous attempts, however, to produce a practical internal combustion engine have resulted in success, the difficulties to be overcome being so great that, up to the present time, only gaseous and liquid fuels have given success.

Regarding the action of the internal combustion engine of today, although almost every conceivable cycle has been tried, it is a significant fact that, since the lapse of the Otto master patent in 1890 every builder of gas engines of note, so far as I have been able to learn, not already manufacturing such engines, have put upon the market engines running upon either the original Otto cycle or upon a modification of this cycle.

The efficiency of the gas engine has been very materially increased during the last 10 or 12 years. For example, the Crossly Otto engine of a certain size, as built in the years 1882, 1888 and 1894, showed absolute indicated efficiencies of respectively 17, 21 and 25 per cent., the compression pressures being respectively 38, 67 and 88 pounds. This is what should be expected since theoretically, neglecting all losses and imperfect action, the efficiency of this type of engine may be shown to equal unity minus the ratio of the absolute temperature of the charge before compression to the absolute temperature after compression. From this expression it is apparent that an increase in compression is attended by an increase in efficiency. This is also very clearly shown in Fig. 17 (from Proc. Inst. C. E., Vol. 124, Pt. 2) representing cards from these three engines plotted to the same scales of pressures and volumes. In this figure, ab represents in each case the volume of the cylinder at the end of the induction stroke. At the end of the next, or compression stroke, this volume of gases would be compressed to the volumes ac, ag and al respectively, in the engines above referred to as being built in 1882, 1888 and 1894, the corresponding compression pressures, cd, gh and lm, being, as stated, 38, 67 and 88 pounds. It will be noticed that the ratio of the area of card No. 2 to the area of No. 1 is greater than that of the corresponding volumes, bg and bc, of the charges drawn into the cylinders of the respective engines. This would imply that more work was done by a certain quantity of gas in No. 2 than in No. 1. It is also apparent that more work would be done by the same quantity of gas in No. 3 than in No. 2. As above stated the absolute indicated efficiencies, obtained by actual trial, were 17, 21 and 25 per cent. In the Hugon engine, which admitted and exploded the charge without compression, the efficiency probably did not exceed 5 to 8 per cent. It would appear from these figures, then, that compression, in this type, is a very essential feature of gas engine economy, and that the high efficiencies of to day are due chiefly to high compression.

From the report of Mr. Victor A. H. McCowen, of Belfast, of a recent tests made by him upon an engine of 120 indicated horsepower, built by Messrs. Dick, Kerr & Company, I have abstracted the following: The engine tested was a two-cylinder, double acting tandem engine, with cylinders 13.5 and 13.75 by 20 inches stroke, and ran at 160 revolutions per minute, receiving an impulse each stroke. In this gas engine there is a nice adjustment of work done in the cylinder to the demand for power. The compression pressure is maintained constant at all loads, and for light loads the pressure is well maintained throughout the stroke. The fact that the compression pressure remains constant for all conditions of loading would suggest, as is in fact the case, that the quantity of air supplied to the cylinder on each induction stroke is always the same. This nice graduation in the impulses, then, is obtained by varying the quantity of gas admitted to the cylinder. The manner of doing this requires explanation, since, as is well known to those who have had experience with gas engines, the proportion of gas in the mixture does not permit of great variation. In this engine, however, as the demand for power gradually decreases, the governor responds by admitting the gas to the cylinder later and later in the charging stroke, the gas even at full power being preceded by a considerable quantity of air. It would appear from indicator cards that stratification did actually exist in

* From a paper read before the Engineers' Society of Western Pennsylvania, Feb. 16, 1897.

the cylinder of this engine, that is, there was at the end of the compression stroke a portion of rich explosive mixture in the combustion space, the rest of the cylinder being filled with air. This engine ran with as great regularity as a double-acting simple steam engine. The ignition was by hot tube controlled by a timing valve, and the engine was started by compressed air.

UTILIZATION OF WASTE HEAT.

From the results of a number of tests made upon modern gas engines, ranging from 20 to 100 horse-power, it would appear that from 72 to 80 per cent. of the heat supplied to the engine is discarded. Neglecting the radiation losses, they being quite small, we can then credit the jacket water and the exhaust gases with carrying off, on the average, about 75 per cent. of the heat supplied

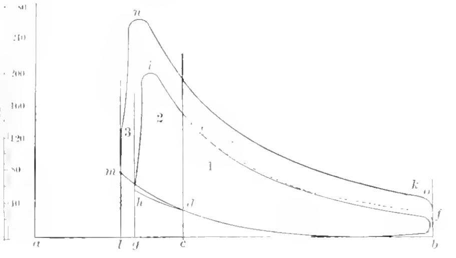


Fig. 17.

to the engine. The discarded heat amounted, by actual test, to 7,400 British thermal units per indicated horse-power hour in the Crossly-Otto engine referred to in this paper, and would probably be 7,200 British thermal units per indicated horse-power hour in a similar engine of 100 horse-power capacity. Upon this assumption, then, an engine of 100 indicated horse-power, while running continuously at full load, would discard to these two sources heat at the rate of 720,000 British thermal units per hour. Using average values obtained from results of tests upon four engines, I find that of this 720,000 British thermal units, 338,000 would probably pass into the jacket water, and the remaining 382,000 would pass off in the exhaust gases. The temperature of the exhaust gases in this case would probably not be less than 1,700 degrees Fahr.

There are a number of ways by which this rejected heat may be utilized and of these I shall ask you to consider two.

First, by utilizing the rejected heat in the generation of steam for power purposes.

An engine designed with this object in view could be arranged so as to utilize practically all the heat lost to the jacket water and by properly proportioning the heating surface of the steam generator, the greater part of the heat resident in the exhaust gases could also be withdrawn. Assuming that the steam is to be generated at a pressure of 100 pounds gage, the feed water being at a temperature of 185 degrees Fahr., it would require 1,100 British thermal units to generate one pound of steam. The temperature of saturated steam at the assumed pressure being 338 degrees Fahr., it would be practicable to reduce the temperature of the exhaust gases to, say, 550 degrees Fahr. We could, therefore abstract sufficient heat from these gases to reduce their temperature by 1,150 degrees Fahr. Assuming the specific heat of these gases to remain constant over this range of temperature, which is practically the case, we can easily deduce that 68 per cent. of the heat contained in the products of combustion can be abstracted. The total amount of heat available, then, in an engine of 100 indicated horse-power would be, approximately, neglecting radiation losses, 338,000 plus 68 per cent. of 382,000, or 598,000 British thermal units per hour. Deducting 10 per cent. for radiation losses, we get as a net result 540,000 British thermal units per hour.

This amount of heat would, under the assumed conditions, generate steam at the rate of 490 pounds per hour. From this we can see that the indicated horse-power of a single 100 horse-power gas engine could be increased by about 10 to 12 per cent. This small gain in power would not be a proper return for the extra outlay and trouble involved. If, however, the plant were large enough to warrant the installation of a compound condensing engine, this increase in power might reach under favorable conditions as much as 30 or even 35 per cent. I believe that an installation of this sort would, for plants of 1,000 horse-power or over, prove to be economical in the generation of power, especially in localities where fuel is expensive. Since the steam engine, in this case, could not be governed in any of the usual ways, it would be necessary to connect it in some manner to one of the gas engine units. The best arrangement doubtless would be to have one or more of the gas engine units constructed as a steam gas engine, with the steam and gas cylinders arranged tandem, or at least connected to the same crank shaft. This would be a perfectly practicable arrangement, and should not be confounded with any of the various methods that have been tried, but without success, of introducing the steam into the gas engine cylinder.

Second, by utilizing the discarded heat for warming buildings, drying, cooking, etc. In shops, factories, office buildings, hotels, restaurants, laundries, etc., the waste heat from gas engines could be used in most instances to greater advantage than that from steam engines.

For general warming purposes I believe that a hot water system would, in most cases, be the best to install. It would possess the advantage of being applicable to gas engines as now built without necessitating any change in the engines proper, besides being safe convenient and economical. The arrangement that I have in mind is as follows: The main return from the hot water heating system is connected to the engine at or near the bottom of the water jacket. The top of the water jacket is connected directly to a heater, through which the exhaust from the engine is made to pass, the heater being connected to the main flow pipe of the hot water heating system.

The action would be as follows: The water from the main return of the heating system entering the engine jacket at say, 110 degrees Fahr., would leave at a temperature of, say, 135 degrees, carrying with it the heat ordinarily rejected to the water jacket. It would then enter the heater at a temperature of 135 degrees and leave at say 165 degrees, having reduced the temperature of the exhaust gases to say 300 degrees which would be practicable in a well-designed heater. This of course presupposes the rapid circulation that is so desirable in most hot water heating systems.

Assuming, as before, that the temperature of the exhaust gases is 1,700 degrees Fahr., it would be practicable to abstract enough heat to lower their temperature 1,700 degrees minus 300 degrees, or 1,400 degrees. Under favorable conditions, then, we could abstract 82 per cent. of the heat ordinarily rejected in the exhaust gases. The total amount of heat available for heating purposes then in an engine of 100 horse-power capacity running at full load, deducting 8 per cent. for radiation losses, would be at the rate of 600,000 British thermal units per hour.

From the reports of the U. S. Signal Service, it would appear that the mean temperature at Pittsburgh for the months of November, December, January, February and March, are respectively 40, 31, 29, 31 and 39 degrees, making an average, for the five coldest months, of 34 degrees Fahr.

Using the formula $h = (n\,C / 55 + G + W / 4)\,t$, in which C is the cubic contents of the room or building, W the area of exposed wall, G the area of glass, n the number of changes of air per hour, t the difference between inside and outside temperatures, and h the number of heat units required per hour; I get my substituting average values obtained from a recently constructed business block, the formula $C = 14\,h / t$.

The rejected heat from the 100 indicated horse power engine considered would then, while running under full load, maintain a temperature of 70 degrees within a building having a volume of $C = 14 \times 600{,}000 / (70-34) = 233{,}000$ cubic feet, or a floor space of about 20,000 square feet, the temperature without being the mean obtained for the five coldest months at Pittsburgh. In an office building this same engine would furnish sufficient heat, under the above conditions, for 58 rooms, the rooms having an average volume of 4,000 cubic feet. For zero temperature outside, however, and 70 degrees within, the volume heated would be reduced to 120,000 cubic feet, or in the office building considered to 30 rooms, leaving 28 rooms to be heated from some other source. On the other hand, when the temperature rose above 34 degrees some of the rejected heat would have to go to waste.

If this same engine be placed in a building having a volume of 480,000 cubic feet, it would furnish enough heat to maintain a temperature of 70 degrees within, when the temperature without was 52 degrees; while for zero temperature it would furnish but one-fourth the heat required. It would then be necessary to place one or more additional heaters in circuit between the engine heater and the main flow pipe of the hot-water system. For the mean temperature at Pittsburgh, during the five coldest months, this engine would furnish a trifle over 50 per cent. of the heat necessary.

I am well aware of the fact that in buildings of the character considered, there is ordinarily, during the day, a demand for but

a small fraction of 100 horse-power. But the demand for this amount of power could be easily created through the business portions of our cities. What I refer to is the placing at convenient locations, in the basement of such buildings as could best utilize the discarded heat from gas engines, plants of from say 50 to 500 horse-power capacity, such plants to furnish power for the elevators, printing presses, etc., located within a convenient radius. For such service, with hydraulic transmission arranged with provision for a moderate storage, the load upon the engines could be kept practically constant during the business hours of the day.

This proposed method of utilizing the waste heat from gas engines would also be well adapted to shops, factories, laundries, in fact to any building in which both power and heat are required.

COST OF POWER.

The best modern gas engines of from 50 to 100 horse power, running at full load, will show a heat consumption, when using illuminating gas of average composition, of 10,000 British thermal units per indicated horse-power hour, or 11,500 per British horse power hour. If we take as average values for illuminating and natural gases, respectively, 675 and 1,000 British thermal units per cubic foot, we get the gas consumption per horse-power hour as follows: First, for illuminating gas per indicated horse-power hour, 14.8 cubic feet, and per brake horse-power hour, 17.0 cubic feet; second, for natural gas per indicated horse power hour, 10.0 cubic feet, and per brake horse-power hour, 11.5 cubic feet.

I have been informed by the Pittsburg representative of a leading gas engine builder, that from their experience it would appear that the indicated work obtained from the use of these two gases is not in proportion to their respective heating values; that, whereas the average heating value of natural gas is about 50 per cent. greater than of illuminating gas, the indicated work per cubic foot, as compared with that of illuminating gas, was found, in a number of instances, to be from 5 to 10 per cent. greater. I am inclined to believe that the heating values of the gases may not have been up to the average, or that the best proportion of gas to air was not used. However, in order to be upon perfectly safe ground, I have assumed as a basis for my estimates, instead of the 11.5 cubic feet obtained, 16 cubic feet of natural gas per brake horse-power hour.

My estimate for the cost of 100 brake horse-power for 309 days of 10 hours each, allowing the rejected heat to go to waste, is as follows:

Interest on cost of plant, $3,500 at 6 per cent	$210.00
Depreciation and repairs, at 7 per cent	245.00
4,944 thousand feet natural gas at 15 cents, net	741.60
Attendance, ¼ time at $2.50 per day	193.13
Supplies	120.00
Total cost of 100 brake horse-power per annum	$1,509.7

This is at the rate of $15.10 per brake horse-power per annum upon the supposition that the engine runs at full power for 309 days of 10 hours each.

Running upon the same service, but at one half load, assuming that the thermo-dynamic efficiency remains constant, which would be practically the case for an engine governed by the hit and miss method, and also assuming a mechanical efficiency of 87 per cent. I get as follows:

Interest on cost of plant, $3,500 at 6 per cent	$210.00
Depreciation and repairs at 6½ per cent	227.50
2,794 thousand feet natural gas at 15 cents, net	419.10
Attendance, one-quarter time at $2.50 per day	193.13
Supplies	100.00
Total cost of 50 brake horse power per annum	$1,149.73
Cost per brake horse-power per annum of 309 days of 10 hours	22.99

Running upon the same service, but at one-fourth load, the cost of 25 brake horse-power would be $38.43.

Assuming that this engine runs under a load that varies from 25 to 100 brake horse-power, so that the summations of the time intervals at intermediate points are practically equal, then the cost per brake horse-power per annum would be $25.51.

In these estimates no rental charge for space has been entered, because of the fact that an engine of 100 horse-power, of the vertical multiple cylinder type, would require a floor space of not more than 5 by 8 feet, and could be placed in the least valuable part of the basement.

No charge was entered for jacket water supply, because the jacket water could be cooled by being circulated through a tank, or cooling coils, located on the roof, or at other convenient place outside of the building. This could be accomplished, for average conditions, at an extra cost of about 45 cents per brake horse power per annum, which is of course, quite insignificant.

My estimates, then, for the cost of power, when generated by gas engine units of 100 brake horse-power, located in the basements of suitable business buildings of Pittsburgh and Allegheny, would be, for natural gas and upon the basis of 309 days of 10 hours, as follows:

1.	When running at full load	$15.55
2.	When running at one-half load	23.44
3.	When running at one-fourth load	38.88
4.	When running at from one-fourth to full load	25.96

Should the rejected heat be utilized for heating purposes, in the manner that has been proposed in this paper, no extra expense of consequence for installation need be incurred, since the cost of the apparatus necessary to abstract heat from the exhaust gases would be practically offset by the reduction in cost of the other heating apparatus.

I shall make no attempt in this paper, as to do so would make it unduly long, to estimate the value of the rejected heat when utilized in the various ways suggested. The amount of heat, however, that could be utilized for heating purposes, at practically no expense, may be deduced from what has been given, and would be as follows:

		British thermal units per hour.
1.	Engine of 100 brake horse power, at full power	690,000
2.	" " " " at one-half power	391,000
3.	" " " " at one-fourth power	240,000
4.	" " " " at one-fourth to full power	440,000

Using the formula derived for average conditions, namely, $G = 11h . t$, I get, by substituting the proper values given for Pittsburg, the following for the cubic foot of space that could be heated, when the temperature without is the average for the five coldest months:

		Cubic feet of space.
1.	Engine of 100 brake horse power, at full power	269,000
2.	" " " " at one-half power	152,000
3.	" " " " at one-fourth power	94,000
4.	" " " " at one-fourth to full power	172,000

Recent Arbitration Committee Decisions.

Last month we published in full one important recent decision of the M. C. B. Arbitration Committee, and in what follows we abstract several others of some importance:

Case No. 381, between the Pennsylvania Railroad and the Phil. & Reading, involves an allowance for scrap credits for parts of a car missing and broken and replaced by the latter road. The only credits it allowed were for such parts as were damaged, but not lost. The Pennsylvania claimed that the rules required scrap credits for missing parts and in this respect were just, for the missing parts must be in the possession of the road at some point along its line. In this claim it was sustained by the Arbitration Committee.

Case No. 383 is an unusual one, though it belongs to a class that should never come before the committee, as the right and wrong in the case is too evident to need a decision. The Texas Central road had a flat car that left its lines in 1889. After two years it was reported in such bad condition as to require general overhauling to get it home. Authority for this was not given, but in 1895 the C. O. & S. W. Ry. asks authority to repair it sufficiently to make it safe to send home. Authority is given, and under this authority rotten parts are replaced and a bill of $65.77 rendered. This the road refused to pay, but the Arbitration Committee decides that the bill is just.

Case No. 388 is between the Great Northern and the Duluth & Iron Range. The latter road has some new cars built, and these were delivered to them over the line of the Great Northern. One car had every wheel slid flat to such an extent as to be ruined. The Great Northern replaced them and rendered a bill, claiming that the pipe to the retaining valve was full of chips which prevented the brakes from properly releasing on a long grade. It had tested the brakes before the train started, and though the brakes then released, the Great Northern assumed that the operation was accidental. The committee held the Great Northern responsible because the defect in the brake would have been detected if its inspection had been thorough.

In the course of a few weeks it is expected that the Hardie compressed air motor will be in service on the Ninth avenue elevated line in New York City. The air compressing plant is complete, as is also the motor, and the connections from the powerhouse to the charging point on the elevated structure are being made.

Diagram for Determining the Lengths of Rivets.

The accompanying diagram for determining the length of rivets is in use in the Bureau of Steam Engineering of the Navy Department, and provides a means for promptly finding the length of rivets without calculation of any kind. The diagram is based on the assumption that all rivet holes are $\frac{1}{16}$ of an inch larger than the rivets; that the riveting is done by machinery, and that the two heads of a rivet are alike and of the following dimensions:

Diameter of rivet.	Greatest diam. of head.	Least diam. of head.	Thickness of head.	Weight of ten heads.
Inches.	Inches.	Inches.	Inches.	Pounds.
$\frac{7}{16}$	$\frac{13}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	.331
$\frac{1}{2}$	$\frac{15}{16}$	$\frac{7}{16}$	$\frac{1}{2}$	.531
$\frac{9}{16}$	1	$\frac{1}{2}$	$\frac{9}{16}$	.731
$\frac{5}{8}$	$1\frac{1}{8}$	$\frac{9}{16}$	$\frac{5}{8}$	1.007
$\frac{11}{16}$	$1\frac{1}{4}$	$\frac{5}{8}$	$\frac{11}{16}$	1.373
$\frac{3}{4}$	$1\frac{5}{16}$	$\frac{5}{8}$	$\frac{3}{4}$	1.551
$\frac{13}{16}$	$1\frac{7}{16}$	$\frac{11}{16}$	$\frac{13}{16}$	2.032
$\frac{7}{8}$	$1\frac{1}{2}$	$\frac{11}{16}$	$\frac{7}{8}$	2.258
$\frac{15}{16}$	$1\frac{5}{8}$	$\frac{3}{4}$	$\frac{15}{16}$	2.871
1	$1\frac{3}{4}$	$\frac{13}{16}$	1	3.581
$1\frac{1}{16}$	$1\frac{13}{16}$	$\frac{13}{16}$	$1\frac{1}{16}$	3.910
$1\frac{1}{8}$	$1\frac{15}{16}$	$\frac{7}{8}$	$1\frac{1}{8}$	4.761
$1\frac{3}{16}$	2	$\frac{7}{8}$	$1\frac{3}{16}$	5.170
$1\frac{1}{4}$	$2\frac{1}{8}$	$\frac{15}{16}$	$1\frac{1}{4}$	6.215
$1\frac{5}{16}$	$2\frac{1}{4}$	1	$1\frac{5}{16}$	7.391

Our reproduction of the diagram is exactly one-half scale and if our readers will imagine it to be full size the method of using it is this: Apply a common rule to the diagram along the horizontal line which corresponds to the diameter of the rivet under consideration and read off the distance in inches from the line A B to that line which indicates the sum of the thickness of the plates through which the rivet is to pass: the result will be the correct length of the rivet measured from under the head. As an example assume that a $1\frac{1}{8}$-inch rivet is to be used and the plates sum up to the thickness of $2\frac{3}{4}$ inches: look for $1\frac{1}{8}$ on the line A B and measure from it to the point where the horizontal intersects the curve marked $2\frac{3}{4}$. The distance (on the full size diagram) is $5\frac{1}{16}$ inches, which is the correct length under the head.

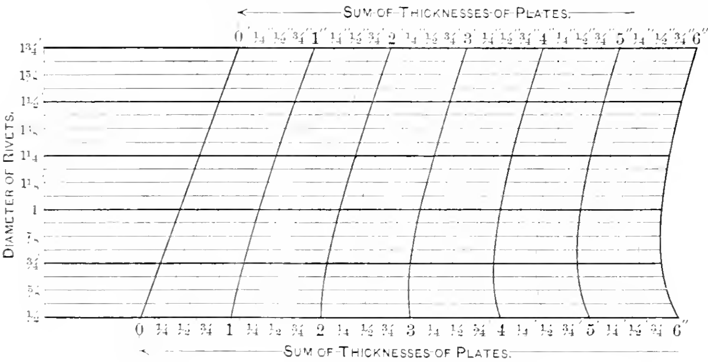


Diagram for Determining the Length of Rivets.

This is one of those handy diagrams which every engineer and designer appreciates for the saving of time arising through its use. Those desiring to make one for themselves can just double the size of our engraving, vertically and horizontally, and the scale will then be full size so that the sizes can be read off with a common rule.

The Canadian Manufacturer, published at Toronto, Canada will publish a special edition containing the new Canadian tariff the new United States tariff, the British tariff and the British Merchandise Act. This special edition will appear as soon as the new tariff becomes law.

Elasticity and Fatigue.

H. K. LANDIS, E. M.

PART 1.—ELASTICITY.

The primary consideration in investigating the quality of structural material is that combination of properties which will render behavior in service a constant factor. This is especially true of all high-requirement material, such as iron and steel, particularly the latter. The principal factor upon which the invariability of steel depends is the property known as elasticity, for while retaining its elasticity the ability of steel to resist stresses externally applied is very great. When, however, the stresses are of such nature or magnitude as to destroy the elastic properties of the material, fatigue results, and the material succumbs after a comparatively short time in service. It is therefore of primary importance that we understand the factors which produce, influence or destroy this elastic condition of steel, and especially those influences which tend to cause failure of the material through fatigue.

Elasticity.—The celebrated physicist Sir William Thompson defined this term as "that property in virtue of which a body requires force to change its bulk or shape, requires a continued application of the force to maintain the change, and which springs back when the force is removed." Perfect elasticity can exist only in isotropic bodies; such bodies are homogeneous solids which are uniform in composition, equally elastic in any direction, and conduct heat and electricity, or radiate heat and light with equal facility in all directions. Evidently steel is not an isotropic body; M. Mercadier has shown this conclusively in his very interesting experiments indicating that steel lacks physical homogeneity, and that "elasticity can vary much in the direction of certain radii." In criticising the statements of M. Hartmann that "metals acts like homogeneous bodies" M. Georges Charpy says: "Chemical action shows, after as before deformation, that there are constituents which are attacked unequally, and according to results obtained, which are also unequally deformable." It therefore follows, as steel is subject to segregation, local irregularities and other defects due not only to its handling, but also to the nature of the material, that steel is not isotropic and consequently *not perfectly elastic.* This is a fact which must not be lost sight of, for it explains several puzzling phenomena, and has caused Mr. Burr to remark that "some experimenters . . . have been led to believe that a very small permanent 'set' exists with any degree of stress whatever," and therefore that incipient failure begins from the moment any load, however small, is applied. Such generalizations are dangerous and misleading, so we will be contented with the statement that steel is not isotropic and therefore cannot be perfectly elastic. We may also take the liberty to modify Sir William Thompson's definition, and say that a body is perfectly elastic when it returns to its *initial condition* after change of form by an external force.

Granting that steel lacks the property of being perfectly elastic, and that this imperfection exists in varying degrees, we may ask in legal parlance, "If so, why so?" Iron unites with metallic alloys such as nickel, manganese, chromium, etc., in all proportions; it combines with carbon in quantity up to probably four per cent., though commercial steels usually contain from 0.09 to 0.5 per cent. of carbon. When a very large ingot of steel is left to cool slowly, there is a tendency for the foreign components to go off by themselves, to segregate and separate from the congealing iron, just as ice excludes impurities in water

while being frozen, and thus forming local and regional segregations, which vary considerably in composition from the remainder of the steel ingot. Nickel, sulphur, phosphorus, slag and carbon to a less degree are thus liable to collect, forming plates or bars which vary considerably in chemical composition, and consequently in elongation and elastic properties; per cent. elongation may vary two points for every .0105 per cent. carbon, while the elastic limit may vary 1,000 pounds per square inch for each 0.01 per cent. carbon. As the nickel, when alloyed in quantities of 3 per cent., may increase the elastic limit 15 per cent., and a 5 per cent. nickel alloy by 50 per cent., we see how the other impurities may, by their unequal distribution, give adjacent particles entirely different elastic qualities. The presence of blowholes, hollow pipes and lamination due to internal fractures or cold working are often hard to detect, and are the most glaring of irregularities. Residual internal stresses due to forging at too low a temperature, cold working, unequal cooling, etc., are, unfortunately, little known, and are some of the most fruitful sources of fatigue, and the most insidious of the destroyers of elasticity. Again there are such local partial deformations as "gag marks" in straightening beams, rails or rods, hammer marks, the effects of punching, shearing, stamping, etc., all of which form a good start for the progressive breaking down of the material. The specific gravity or density also is changed by handling and treatment. M. Caron by 30 successive heating and quenching operations reduced the density of steel from 7.817 to 7.743. Mr. Horace Allen changed the density of a mild steel billet, by rolling into a rod, from 7.826 to 7.865, and then back to 7.852 by subsequent annealing; this rod was drawn into No. 10 B. W. G. wire which had a specific gravity of 7.815, or after annealing 7.824. Cold rolling also increases the density; according to Mr. Lanza it also increases the limit of elasticity 80 to 125 per cent., although it would be interesting to know how he determined this limit, for by the usual tests there is no very decided jog in the stress-stretch curve with cold-rolled or cold-drawn unannealed rods or tubing.

It therefore becomes very evident that when any or all of the aforesaid influences have been at work on steel, its degree of elasticity will depend upon the extent of these influences. The determination and evolution of such destructive factors is by present methods impracticable, except as they occur in such a manner as to be shown in ordinary testing. Ordinary masses of steel are quite constant in chemical and physical composition, though the same cannot be said of internal stresses present in nearly all steels. Material which has been bent cold has four zones of alternating tension and compression; rolled rods cool more quickly on the exterior and have, when cold, the exterior in compression and the interior in tension. Rodman cast-iron guns have 10,000 pounds per square inch compression on their internal bore and 4,000 pounds per square inch tension on the outside purposely secured by cooling the interior and heating the exterior after casting; ordinary forged material will have stresses from 1,000 to 10,000 pounds per square inch initial stresses, which usually cannot be determined without destroying the material; imagine the body of a material you are about to test to be filled with conflicting tensile and compressive stresses, whose magnitude you have no means of knowing, and then follow their action as a piece of steel is slowly pulled apart—why, even the turning of a test specimen creates initial stresses, rough turning putting the surface in probably 2,000 pounds' tension, while a small cut with a dull tool will put it in compression and raise the unit tensile strength by several thousand pounds. These are facts known to well-informed testing engineers. Under the influence of such stresses some particles may even be stressed beyond their elastic limit and form permanent sets before others are out of compression and then we will have progressive destruction from the start; this is what happens with cold-rolled or cold-drawn steel in varying degrees; for not only tensile but also endurance tests show that though such material in the unannealed state has a high tensile strength, yet it has no well-defined limit of elasticity. Such considerations are doubtless what led that careful engineer James Christie to say that "The elasticity of either steel or iron is so variable and uncertain that it is difficult to assign a definite value to any particular material except by taking the average of numerous experiments." Generally speaking steel is said to be elastic while the ratio of the successive loads per square inch of cross-section divided by the resulting stretch in decimals of an inch per inch in length remains a constant factor; [for a steel which stretches 0.0003 inch for each 1,000 pounds per square inch load applied this factor would be $33\frac{1}{3}$ million.

Elastic Factors.—Let us now look at the various terms used in defining elasticity in steel and the methods used in determining them. In the testing of steel, as the stresses increase from zero we pass successively through the elastic conditions determined by the coefficient of elasticity, through the several limits as determined by our various authorities, and which often vary as much as 10,000 pounds per square inch, into the condition of progressive destructive, and end with fracture of the material at the tensile strength or breaking load. We will arrange them as follows:

1. Dynamic coefficient for modulus of elasticity (Ed.).
2. Static " " " " (E.).
3. Limit of proportionality (L. P.).
4. Elastic limit (yield point, 1st permanent "set") (E. L.).
5. Elastic limit (drop of beam).
6. Ultimate tensile strength (breaking load) (T. S.).

Methods of Testing Elasticity.—In order to still more fully understand what is meant by elasticity in the commercial and scientific world, a condensed description of the methods in use will be necessary. There are two classes of machines in general operation—the lever machines, such as are used in the smaller works and laboratories and in colleges, and the few more complicated machines of which the Emery is a type. The former has power supplied to it by either screws operated by hand or from a line shaft and belt, or by a hydraulic cylinder using oil supplied by a duplex pressure pump. These sources of tension are attached to one end of the bar to be tested by means of movable jaws or clamps; the other end of the bar is fastened by similar wedges or jaws to a plate bearing on a series of double compound levers which terminate in a long scale beam, over the graduations of which a weight is made to roll under control of the operator. When, therefore, the power of the screw or hydraulic pressure causes tension in the test rod, this tension is transmitted at the other end through the series of levers to the scale beam, where it is measured in pounds by moving the weight along until the beam is balanced and vibrates freely; this load, divided by the area of cross-section of the test piece in square inches, will be the unit stress in pounds per square inch when square inches and pounds are used. Tons (2,240 pounds) per square inch are used in England, while kilograms per square millimeter are used on the Continent (1 kilogram per square millimeter equals 1,422.3 pounds per square inch). In some cases the tension is measured, not by levers, but by a pressure gage, a mercury manometer or other methods, and this is especially the case with machines for testing full-sized members such as eye bars for bridges. The Emery machines are more accurate throughout, are of greater capacity, are very sensitive and easily controlled. Hydraulic power is supplied by oil pumps and the tension measured by adding small weights successively to a scale beam until a balance beam or index indicates equilibrium; any fluctuations in this beam indicate breaks in the constant ratio of stress to stretch, and consequently in elasticity. Elongation is usually measured by a scaled arc extensometer or electric micrometer, sometimes by a fine micrometer screw. As far as the writer is aware, the "mirror apparatus" described by Mr. Henning (American Machinist, Feb. 11, 1895) is not in general use on any of the larger machines of this class; the same may be said of similar apparatus used on the Continent by Wedding, Martens, Rudloff and other investigators. As elasticity is reckoned in terms of elongation, it is apparent that the accuracy of the elongation determination establishes at once the accuracy of the elasticity determination. Stretch is gotten by various methods, nearly all of which depend somewhat on human judgment, never at best infallible, and so we may expect to find some startling results. When investigating this subject Mr. Webster sent samples of the same steel from the same bar to seven differ-

ent works and laboratories, and received the following determinations of elastic limit: 37,200, 37,350, 37,490, 38,900, 39,090, 39,700 42,400. This was on a 0.19 per cent. carbon steel by presumably the same method. He further says: "By the present methods in use no reliance whatever can be placed on the elastic limits reported," and says he knows of cases in which the test piece had stretched three-tenths of an inch beyond the yield point before the elastic limit was taken. This condition of affairs as stated seems somewhat abnormal, so let us look at the method employed in the ordinary lever machines in use.

Drop of Beam.—The test specimen is prepared in various ways. Bessemer heat tests are rolled into flat bars and center-punch marks made on them 8 or 10 inches apart, the width and thickness recorded, bar placed in the jaws of the testing machine, the driving belt thrown in or steam turned on the pump, and then the operator moves the weight along the balance beam in such a manner that it vibrates freely about the middle of its range, until a load is reached where it suddenly drops, and a few moments elapse before it gradually regains its middle position again: this load is the elastic limit determined by "drop of beam." We here see that it is assumed that the rate of application of load is uniform, as it is, approximately; that the rate of stretch is proportional to the rate at which the load is applied, as it is, approximately: therefore, that when the rate of stretch suddenly increases, the rate of loading being constant, the weight must be moved more slowly; consequently the limit of elasticity must lie somewhere near the point where the rate of stretch changes, as it does—approximately—very approximately. Now, how will we account for the drop of the beam? It is well known by those who have tested much material that where steel is slowly stretched until broken that the rate of elongation of small parts of the length is not always the same for each: first one division will stretch, then make a stubborn stand, then another and still another, showing local weakness, until the middle divisions elongate and the piece breaks. This takes place with all stresses, and makes the elastic curve quite irregular. Howe and Kreuzpointner have shown that the stretch of each division is not proportional to its distance from the break, but that they are quite irregular. We can then say that partial failure and recovery is a property of stretched steel, and that this stubborn resistance before the material jumps to its next place to hold on may prolong the unit resistance beyond the point where a proportional elongation would place it. The drop of the beam is evidently caused by such a jump and recovery: therefore, according to the preceding explanation, we can say that this point is too high, and such, in fact, is the case, as shown by a number of engineers who have carefully investigated the subject. More exact methods are employed where the limit of elasticity is defined as the point of first permanent set. Formerly but a single center-punch mark was made on a test piece, one leg of a dividers spaced 8 inches placed in it and a mark scratched with the other on a chalked surface near the other end, at a distance of 8 inches; then loads were applied until somewhere near the elastic limit suspected, and another scratch made on the chalk. Then unit loads of about a 1,000 pounds, successively applied until the scratches or scribe-marks predicted a sudden increase in the stretch, when but 500 pounds were applied until there was undoubtedly a suddenly increase in elongation. This was the elastic limit and was corroborated by the cracking of scale on the specimen, the extra number of turns of the screw or strokes of the pump to produce the load, and the drop of the beam. This gave closer results than simply the drop of the beam. Permanent "set" methods succeeded, for it was found quite difficult to determine accurately the differences of 0.0003 of an inch for each load applied on a chalked surface full of lines previously made.

Permanent Set.—A set takes place when the material does not return to its original length, and, according to Sir W. Thompson, there its elasticity ends. Therefore, after stretching the test piece to near the elastic limit, the load was entirely released and the distance between two punch marks measured. If no change was evident with the micrometer used another unit load was applied, decreasing from 4,000 to 2,000, 1,050 and 500 pounds, and the same measurements taken as before, until a decided increase in the amount of stretch is noted, usually not more than 0.0001 inch per 1,000 pounds in 8 inches. By fastening an electric contact micrometer to the test specimen at both punch marks, a bell rings when the specimen returns to its original position and ceases to ring when it does not. A micrometer screw then determines the amount of "set."

Proportionality.—There is another point which is not usually determined in our laboratories, although it is quite common in France and Germany, and is known as the limit of proportionality. We have seen before that the "drop of beam" depended on the assumption that it had *something* to do with elasticity; that may or may not be so, but we *are* certain that it has something to do with failure, and is the palpable evidence of progressive destruction. We have also seen it claimed that the first permanent "set" had some intimate or remote relations with elasticity; that may or may not be true again, but we *do* know that it is the first evidence we have of actual deformation. Let us then examine into what we know to be an undoubted factor of elasticity.

The modulus of elasticity, formerly called the coefficient of elasticity, is the ratio of the unit load to the unit stretch which it produces. If each increment of load of 2,000 pounds per square inch produced an increment in stretch of 0.00008 of an inch per inch of length there would result a modulus of elasticity of 25 million. This ratio between stress and stretch is a property of elasticity which remains approximately constant in very homogeneous steels, though in many the rate of stretch gradually increases from the beginning, and in others some of the successive elongations vary considerably, apparently by successive jumps; thus we are again reminded that steel is not isotropic. With the electric contact micrometer, the successive elongations are measured after each corresponding load increment, by turning the micrometer screw until the electric bell rings, and reading it, which can be done readily to 1-10000 of an inch. The error of micrometer screws are sometimes considerable, so that a reflecting extensometer such as described by Mr. Henning is quicker and more accurate for such small readings. To describe the latter briefly, the test piece being marked on opposite sides near each end, the base is clamped to the lower marks; from the base rise two springs on either side of the specimen which terminate at the upper mark in two rollers carrying on their extended horizontal axes two mirrors; these small mirrors are adjusted in such a manner that a telescope directed to them at a distance of 5 feet will see the reflection of the zero point on two vertical scales beside the telescope. If now the piece is slightly elongated the rollers in contact with it will revolve, and with them the two mirrors, thus bringing another reading of the reflected scale within the field of the telescope. Thus the actual elongation is magnified to a much greater extent than it would have been with any micrometer screw, eliminating the appreciable errors of thread and graduation, and enabling one to determine exceedingly small changes in stretch.

While the modulus of elasticity is constant the proportionality of unit stress to a unit stretch is also constant; as soon as the next increment of load produces a greater increment of elongation, proportionality ceases, and we have what is called the limit of proportionality. This limit is located at the point where, according to the French commission of tests, an additional 1,000 pounds per square inch load will produce an increase in increment of elongation in 8 inches of 0.000027 of an inch; as the error of a screw micrometer is probably twice this amount, the necessity of improved apparatus is apparent. The Engineering News (July 25, 1895, page 60) suggests the placing of this limit of elasticity at the point where the next elongation will be three or four times what it was between total unit loads of 4,000 to 24,000 pounds. We notice that the limit of proportionality has nothing to do with drop of beam or permanent set; it is a factor of elasticity and not of deformation; it is as much a refinement on the yield point as the yield point was on the drop of beam. So that here we have three distinct limits of elasticity, each with its supporters among our best engineers and metallurgists; we have both a dynamic (as

yet experimental) and a static coefficient of elasticity; add to these the promiscuous manner in which bent, tempered, annealed, cold and hot-worked, uniform and segregated material of known and unknown composition are reported, and then try to guess what a man means when he tells you the steel of a certain lot of rails had an elastic limit of 40,000 pounds; and, therefore, in his opinion, were strong enough.

Comparison of Limits.—To give an approximate idea as to the relative location of the various limits, we can say, and with some basis of accuracy, that the drop of the beam lies (the difference increasing as the carbon decreases) 1,000 to 5,000 pounds per square inch above the yield point; that the elastic limit or yield point lies from 2,000 to 10,000 pounds per square inch above the limit of proportionality, and that the location of the limit of proportionality depends largely upon the delicacy of the apparatus employed and the mechanical condition of the steel. The error of the usual lever machine due to friction, inertia, etc., is about 6 per cent., rising as high as 15 per cent., according to Mr. Henning, when the bearing surfaces are in bad condition. The usual method, in fact, with structural material, almost the only method in daily use, is to determine elasticity by the drop of the beam. Suppose the steel rail having the elastic limit of 40,000 pounds per square inch were inquired into. The error of machine correction of +.06 would bring it up to 42,400 drop of beam E. L. Let us take the yield point at 40,400, i. e., 2,000 pounds lower, and the limit of proportionality 4,000 pounds lower still, at 36,400, which is an error of 8 per cent. and brings the limit of elasticity near the point of rejection of the material. It is, therefore, scarcely necessary to remind engineers that a limit should be included in their specifications which will correspond to each of the three methods of testing. It would also be well to have two series of tests: 1st, a *quality test*, in which all specimens are to be tested in tension in the usual manner *after being annealed* at a stated temperature for a stated time; 2d, a *condition test*, in which the beam is tested for endurance, internal stresses, etc., in a manner which shall be as near a reproduction as possible of the actual service for which it is intended.

All of which goes to show that the usual elastic limit as reported tells us nothing about elasticity unless accompanied by full details. The E. L. as usually reported is therefore very much like the Illinois lawyer who "wiggled-wiggled in, and he wiggled out, and left the jury still in doubt as to whether the snake that made the track was going north or coming back."

What are we going to do about it? Nothing! As long as engineers and purchasers are willing to accept errors of 15 per cent. due to method of testing alone, the laity can have their private opinion, but things will go on as before, notwithstanding.

Dynamic Elasticity.—Referring to the dynamic coefficient of elasticity, and the dynamic method for determining isotropy, it might be said that it is something to think over very carefully. Lagrange first established the equation of equilibrium of elastic metal plates; Poisson applied his general theory of elastic forces to the same and found the conditions of vibration. Kirchhoff (*Comptes Rendus*, 1848–49) produced the equations of equilibrium and movement in an elastic plate. E. Mercadier took up these investigations (*ibid.*, 1884-85-87-88-89-91-92-93) and applied the principles in connection with his own equations to the investigation of circular and rectangular plates in determining the comparative degree of isotropy and elasticity in glass, iron, hard and mild steel, and nickel-steel; the results achieved compared very closely with tests made at the Creusot laboratories. Briefly, his method consists in taking a plate of steel whose thickness has been accurately determined, also its length or its diameter, supporting the plate freely at its nodal lines (a concentric circle whose radius is 0.68 the radius of the disc, or two transverse lines at a distance of 0.22 the length from both ends of the rectangular plate) on two straight edges or on one or three posts, all of cork. The procedure is, with discs, to support the disc on a single point at its center, strike the edge with a cork hammer and note the tone on the musical scale which results; then place the nodal circle on the three cork supports and strike on its center, noting the tone as before; the first tone will be the fundamental, the second the first harmonic of the disc; with rectangular plates the fundamental tone is determined by an electric contact recording chronograph which gives the number of vibrations direct, while in the former case the number of vibrations are found from the tones produced. This is the extent of the practical determinations. The data thus obtained is substituted in the appropriate formulæ and the comparative isotropy of steels examined; the coefficients of elasticity obtained differed but little from those determined in tension, being usually higher. Assuming that the ability to vibrate freely is a function of elasticity, we thus arrive at some interesting results. Mercadier suggests that steels be examined for their nodal lines and says that when sand is scattered evenly on a disc supported at its center, and struck on the edge, that the resulting vibrations will cause the sand to form a characteristic nodal line, and that "to a perfect homogeneity should correspond a perfectly circular nodal line"; he also says that this rarely happens by reason of a "lack of elastic symmetry," though these irregular nodes become more nearly circular as the plate becomes thicker; the sound, also, was found to be more confused as the elasticity became more distorted, and we are reminded how fatigued boiler plates and car wheels are often detected simply by the sound given when struck by a hammer. In connection with the work of Mercadier, those interested will find the investigations of Lamé, Saint-Venant, Wertheim and Chladin quite valuable. We find here a curious relation between this dynamic coefficient and the coefficient due to a static load; it is generally greater by several per cent., which indicates that but a portion of the metal in a tensile specimen resists elongation with its normal ability. Kreuzpointner has shown (Eng. Mag., March) that steel under tension has a tendency to flow. First the interior flows toward the middle, then the surface begins to stretch at the middle length and flows faster than interior, indicating a variation in physical condition of the surface and interior. We may say that this is due to surface work, to internal stresses, to "surface tension," to the property of flow, etc., but we cannot say that it represents actual conditions of the metal in a larger mass. The unit loads are calculated from the original diameter, consequently as the bar stretches, and its diameter and density become less its unit load will no longer be that on the original cross-section. Therefore, the successive increments of load reported are too small; it may even be that the dynamic coefficient obtained from the number of musical vibrations per second is the more nearly correct of the two. The difference was found to be in low carbon steel about five per cent.; in high carbon steel very slight; five per cent. nickel-steel, low carbon, a difference of 14 per cent.: 25 per cent. nickel high carbon steel gave a difference of 55 per cent.; the static coefficient seemed low in each case.

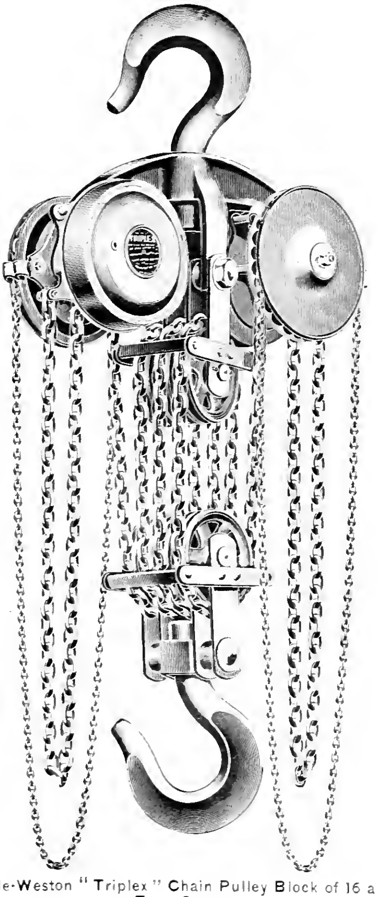
The Holland submarine boat being built at the Nixon shipyards, Elizabeth, N. J., is about 50 feet long, 10 feet 3 inches in diameter amidships, and is cigar-shaped. The shell is of half-inch steel at the greatest diameter, gradually thinning toward the ends. It carries three Whitehead torpedoes. The fuel is to be oil, and compressed air is to be stored in reservoirs at 3,000 pounds pressure for use in operating the torpodoes, expelling water ballast and for the respiration of the crew. The vessel is meant to move through the water with the conning tower above the surface, but it can be entirely submerged, at which time the motive power will be electricity, furnished by a storage battery.

That portion of the Illinois Central Railroad on which it is possible that electricity may be employed as a motive power extends from Randolph street to Sixty-third street, in Chicago, and is about eight miles long. There are thirteen stations in this distance, and the suburban service is undoubtedly the heaviest conducted by any surface steam railroad in this country. The Board of Directors of the railroad have authorized the President to continue his investigations into the expediency of electric motive power, and Mr. Wallace, Chief Engineer of the company, is at work on the problem. It is not expected, however, that the Illinois Central officials are going to make the transformation with the rapidity stated by some of our electrical contemporaries.

The Yale-Weston "Triplex" Chain Pulley Block.

When the Triplex chain block was first introduced a report was published of tests made by Prof. R. H. Thurston, of Cornell University, to determine the relative "mechanical efficiency" of the various types of chain blocks in use, which disclosed the remarkable fact that while the efficiency of seven other types ranged from 18.9 per cent. to 32 per cent. (the Weston differential block being one of the highest) the Triplex spur-geared block developed an efficiency of 79.5 per cent., or nearly threefold the average of other blocks. This result, since confirmed by experience, makes the Triplex block greatly more economical in use than any other wherever the use is frequent and economy of time or labor is material.

In order to meet the demand for blocks of large capacity and high efficiency, two new sizes of the Triplex block have recently been produced by Yale the & Towne Manufacturing Company, capable



The Yale-Weston "Triplex" Chain Pulley Block of 16 and 20 Tons Capacity.

respectively of handling loads of 16 and 20 tons. The accompanying illustration shows the design of these blocks. The construction consists in placing a yoke on the upper hook, each end of this yoke carrying a Triplex mechanism of two tons capacity and each mechanism being operated by an independent hand chain. The two slack ends of the hoisting chain are attached respectively to the two Triplex hoists. The first loop of this chain then passes around the driving sheave in each hoist and thence over two sets of intermediate sheaves, one set carried in the frame of the bottom hook and the other set in the frame connected directly with the shank of the upper hook. The number of parts of chain is such that the maximum load on each part does not exceed 2 tons. In like manner the maximum load on each hoist is limited to 2 tons, and this is the limit of load carried by each arm of the yoke. All the remainder of the load is suspended directly from the shank of the upper hook—a most admirable arrangement. This construction admits of greater compactness and occupies less headroom than any heretofore devised. Still greater compactness and from 18 to 20 inches additional headroom can be obtained by omitting the upper hook and crosshead and building the block into the trolley of a hand crane or overhead tramrail system.

A most important advantage arises from the fact that either or both of the two hoists may be operated simultaneously or independently. The full load may be raised by two men pulling together on the hand chain of one hoist, or at double speed by four men, two on each hoist. In like manner lowering may be effected at varying speeds by using either or both of the hoists. The location of the hoists at the outer ends of the yoke brings the two hand chains somewhat clear of the load and in the most convenient position for effective use.

This ingenious application of the Triplex system adapts it to the largest loads for which portable hoists are usually required, and by reason of the duplication of the hoisting mechanism enables the full power of four men to be utilized either in lifting the maximum load at normal speed, or lighter loads at great speed, whereas all other large hoists have heretofore had but a single hand chain, on which it is not possible to utilize effectively the power of more than two or at the most three men.

Capacity.	Hoist in feet.	Approximate weight.	Minimum distance from top to bottom hook.	Speed of hoist with four men.
16 tons.........	12	1,000 pounds	5 feet 1 inch	0.50 feet per minute
20 tons.........	12	1,150 pounds	6 feet 5 inches	0.39 feet per minute

The above table gives useful information concerning the hoists. Further information is obtainable from the Yale & Towne Manufacturing Company, Stamford, Conn.

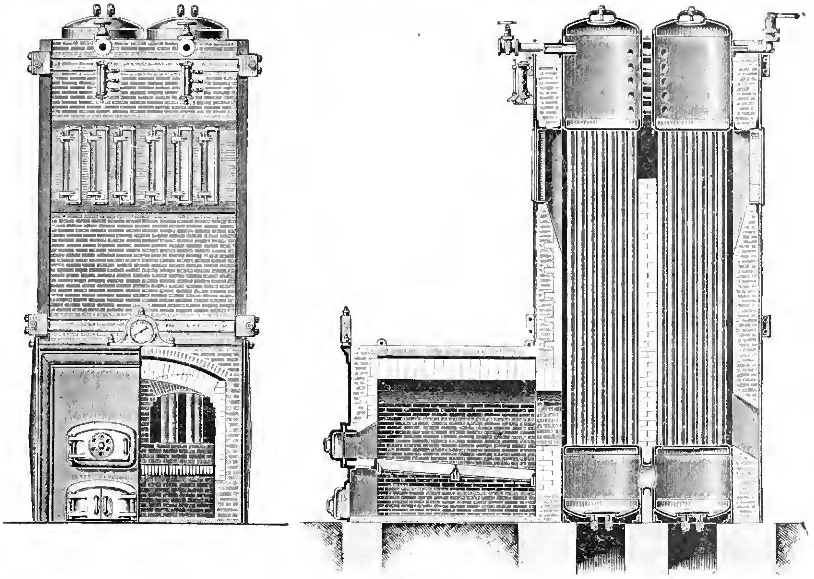
The Philadelphia Water-Tube Safety Boiler.

We show herewith a water-tube boiler built by the Philadelphia Engineering Works, Philadelphia, Pa., in which there are a number of features worthy of attention. In a single setting (the smallest type of complete boiler) there are two steam and two mud drums, joined by straight vertical tubes. The steam drum and mud drum, with their connecting tubes next the furnace, is termed the front set, and those toward the chimney the rear set. Each of these sets are surrounded by walls, forming two square chambers. The combustion chamber is external to these walls, and the gases from it pass through brick arches up the first set, over the center wall, and down the rear set to the chimney.

Connecting tubes join the two steam drums and the two mud drums, providing ample area for the strongest circulation possible, and for the equalization of the steam pressure under all conditions. The vertical tubes are set in rows, extending from front to rear, the space between these rows being greater than the outside diameter of the tubes. Opposite each space in the front and rear walls, openings, closed with doors, are provided to steam-sweep the tubes, and through which tubes may be passed when replacing is required. No doors are provided or required in the side walls, nor wasteful spaces between batteries allowed. A setting may therefore be built with its side walls against any wall or partition, and double, treble or any multiple setting is built with common dividing walls, as in return tubular practice. Much space is thus saved, and the outside radiating surface reduced.

No castings are subjected to heat and steam pressure. The domes are circular, and made of the best steel plate, of ample thickness. The heads are crowned to a radius of the diameter of the drums. The tube heads are especially thick and well stayed where not sustained by the tubes. The walls have heavy angle bars at each corner, held firmly by through bolts. In multiple settings these angles are replaced by tees at each dividing wall. A heavy ornamental front, with fire and ash-hole doors, faces the combustion chamber. This is stayed to the brick wall by horizontal angle bars, from which is sprung the double arch cover of the combustion chamber. A full complement of fittings of ample size and best construction is provided.

For this boiler practically perfect combustion is claimed, the combustion being complete before the gases come in contact



The Philadelphia Water-Tube Boiler.

with the heating surfaces. A strong circulation and the production of dry steam are other claims that seem fully warranted by the form of construction employed. The water level is preferably one fourth way up the steam drum. The most heat is received by the front set of tubes expanding that column of water more than the column in the rear set, and circulation is commenced almost with the starting of the fire. Steam will be formed in the front set first, thus increasing the circulation. The feed water is introduced into the rear steam drum, and mingling with the water forms part of the downward current and assists the circulation. Before reaching the rear mud drum it has attained the full temperature of the water and precipitates its mineral impurities, depositing them in that drum, from which they may be blown out or removed. This drum is so situated that it receives no heat from the furnace. The purified water passes into the front drum and up the first set of tubes. The front set of tubes are then internally clean and full of water unmixed with steam when first presented to the action of the flame. Thus in this boiler the products of a practically complete combustion pass from the furnace and at their highest temperature pass among the tubes just above the mud drum, where these tubes are supplied with water unmixed with steam. In this condition they will absorb the maximum of heat with the least elevation of temperature, injury or deterioration. They absorb heat and keep cool, which is getting heat into the water while maintaining themselves. The gases then rise among the first set and pass down the second set, enveloping all tubes alike. There is no passage of least resistance, no selection of route and no short-cutting.

The company makes two styles of this boiler, the standard and the low boiler. They advocate the standard, but as the gases have to travel double the length of a tube vertically and the diameter of two drums hortizontally, the tubes may be much shorter than common without reducing the gas travel below good practice. Consequently where head room is limited they are prepared to build a shorter boiler. Their standard style is advocated, however, as the cost is less for a given heating surface. This standard style is not excessively high, the extreme height for a 260 horse-power boiler being only 22 feet; for a 60 horse-power boiler it is only 17 feet 7 inches.

Western Railway Charity.

There was brought to our attention recently a case which goes far to disprove the popular calumny to the effect that railroad corporations are "soulless." A farmer living in the Yakima Valley, this State, found it necessary to go to Chicago to have a surgical operation performed. He was very poor and could not pay fare, nor had he any property upon which to raise a dollar. His friends in Chicago succeeded in making arrangements for him at the hospital, but they could not bear the additional expense of his long journey across the continent. He presented these facts to the head office of the Northern Pacific Railway at St. Paul. The application for a pass was forwarded to the Tacoma office, and from thence to the agent of the local station in the Yakima Valley. The agent investigated the case, reported favorably, and the officials at St. Paul promptly forwarded the pass, together with a friendly letter to the unfortunate ranchman.

Now, this Yakima farmer is poor and obscure. He is not a member of the legislature, nor is he on intimate terms with any member of the legislature. He is not, nor is he likely to become, an important patron of the freight department of the road. The issuance of a pass to him could not be expected to add to the wealth or power of the Northern Pacific corporation, and the motive cannot be ascribed to any other influence than the natural impulse of a gentleman of the real sort. There may be "soulless" corporations, but the Northern Pacific is not one of them. Naturally, the farmer was grateful, and, being grateful, he chanced to converse upon the subject with a newspaper representative. No doubt there are many similar cases which have never seen the light of publicity. We should like the members of our Populist legislature to read this little narrative, which is strictly true in every particular.—*Spokane (Wash.) Outburst.*

A Market for Oak Lumber.

Stephen H. Angell, United States Consul at Roubaix, France, says, in a recent consular report, that there exists in the northern part of France a demand for oak lumber, which is largely supplied from the forests of Hungary, and his attention has been called to the fact by dealers in oak lumber that American forests supply a quality of oak which, though said to be slightly inferior to Hungarian oak, could, nevertheless, in a measure, take the place of it. He is informed that, should American dealers in this lumber take the necessary trouble to send agents there, they could, without doubt, secure some of this business. An important firm informs him that they purchase $400,000 worth of oak lumber per year, and that, could they form the proper connections in the United States, they would undoubtedly purchase the entire amount there. They have had small lots of American-grown oak, and state that it has proved satisfactory. Much of this oak lumber is used for cooperage and flooring. The demand is for planks from 6 to 36 feet in length and from 7 to 16 inches in width. The planks sawn from the heart of the tree should be from 9 to 36 feet in length, the average width being 9 inches and the thickness from 1 to 2¼ inches. Planks sawn at right angles with those sawn from the heart, called here the "quartier," should be from 6 to 36 feet in length, from 1 to 2 inches thick, and of an average width of 9 inches.

The planks cut from the corners of the log, between the heart of the tree and "quartier," are used for flooring. The length should be about 6 feet, thickness 1 inch and width about 7 inches. Oak lumber, cut square, is used in considerable quantities also, the sizes approximately being 2¾ by 2¾ inches, 3¼ by 3¼ inches, 4 by 4 inches, 3¼ by 4 inches, 3¼ by 4½ inches. To meet the requirements of the trade all planks should be clear and free from sapwood, bark, etc. There should be no knots or wormholes in first-quality lumber. Sound knots are accepted in second quality. Red oak lumber is not wanted, on account of the wormholes, it not being salable even as second quality.

The Consul offers to put American dealers in communication with dealers in France.

(Established 1832.)

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

28TH YEAR. 66TH YEAR.

PUBLISHED MONTHLY BY

R. M. VAN ARSDALE,

MORSE BUILDING............NEW YORK

M. N. FORNEY, W. H. MARSHALL, } Editors.

MAY, 1897.

Subscription.—*$2.00 a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union.*

Subscriptions for this paper will be received and copies kept for sale by the Post Office News Co., 217 Dearborn Street, Chicago, Ill.

EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Special Notice.—*As the* AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL *is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 25th day of each month.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* **When a subscriber changes his address** *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

The paper may be obtained and subscriptions for it sent to the following agencies: **Chicago,** *Post Office News Co., 217 Dearborn Street.* **London, Eng.,** *Sampson Low, Marston & Co., Limited St. Dunstan's House, Fetter Lane, E. C.*

From and after this date the AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL will be under the editorial management of Mr. George M. Basford, for some years past editor of the Railway Review of Chicago. Mr. Forney, after more than 25 years of active service, has retired from editorial work. Mr. Marshall has accepted an appointment as Assistant Superintendent of Motive Power and Machinery of the Chicago & Northwestern Railway. The readers of this paper will, doubtless, unite with its proprietor in wishing the retiring editors long life and prosperity.

The Holman locomotive has not been taken seriously by railroad men. The idea of placing a pyramid of friction wheels under each driving wheel to multiply speed is not very attractive. To add five wheels under each driver, making a total of 20 for an 8-wheeled and 30 for a 10-wheeled locomotive, appears to sensible men as a joke. But evidently some people will consider it a poor joke before they get through with it. The advertisement of the stock of "The Holman Locomotive Speeding Truck Company" in the New York Sunday papers says that 1,000 shares of the stock are for sale at $50 per share. We learn from private sources that it is being bought in considerable quantities. The capital stock of the company is $10,000,000. Why is it that inventions of genuine merit are so often difficult to finance, while absurdities like the Holman locomotive can find ready support? This mechanical monstrosity will be dangerous at high speed, will produce much friction, consume more coal than the common locomotive doing the same work, will be expensive in first cost and maintenance, and has not one redeeming feature that we can discover.

Whatever may be the final outcome of the large-car problem as applied to box cars and other equipment that is interchanged extensively between railroads, there seems to be little question but that 100,000-pound capacity cars will be extensively used for coal and ore. Inquiries which we have made reveal the fact that a number of the recent designs for 70,000 and 80,000 pound coal and ore cars (from which many have been built) were from the start made strong enough to take 100,000 pounds by putting heavier trucks under them. Then again all those interested in the numerous designs of freight trucks that are coming to notice are providing for a carrying capacity of 100,000 pounds per car.

The recent order of 600 steel cars for the Pittsburgh, Bessemer & Lake Erie road is for cars of this capacity. These cars are to be of metal—steel trucks, steel underframes, etc.—and it looks as if in the near future those roads having a heavy and regular traffic in coal and ore would carry that material in metal cars of 50 tons capacity.

A contemporary notes that several axles have broken under motor cars on the Brooklyn Bridge, and argues that the strains on a motor axle are evidently different in character and much more severe than those to which an ordinary car axle is subjected, and that an especially great torsional strain is likely to exist at the instant of starting. The motor axle, it is said, should be very much heavier than an ordinary car axle, but how much heavier can only be determined by experience such as the Brooklyn Bridge cars are now having. The facts of the case are that there is nothing mysterious in these breakages. Taking the known weights on these axles, and calculating maximum stresses by the methods given in the recent report to the Master Car Builders' Association on 80,000-pound car axles, those stresses are found to be more than 50,000 pounds per square inch. The only mysterious thing about these axles is that they did not all break. They are only 4¼ inches at the wheel fit, and will all have to be replaced by new axles which should be 5⅝ inches in diameter, but which cannot be made more than 5¼ inches because of limiting conditions. Somebody probably guessed at the dimensions of the smaller axles. The material was of the best and the new ones will be of the same manufacture.

It seems strange that at this late day there should be any uprising of labor through the introduction of labor-saving machinery. And yet for more than a month the Amalgamated Engineers in England have been threatening a strike because an employer introduced a new boring machine so nearly automatic in its operation as not to need the attendance of a skilled workman. Such opposition to progress hurts the interests of workmen and employers alike. It has been thoroughly demonstrated that labor-saving machinery in the long run creates a demand for labor through the cheapening of the finished product and the greater demand which arises for it in consequence. On the other hand unreasonable resistance to genuine progress on the part of workmen is only an incentive to the employer to get rid of them whenever he can. The inventor of a labor-saving machine, who in exhibiting it, placed on it a placard which read, "Can do the work of 10 men; never gets drunk; never goes out on a strike," appreciated the needs of possible buyers of his machine and was not slow to point out the failings which too many workmen exhibit. Honesty, industry and steadiness, combined with a recognition of the inexorable laws of advancement and progress, are qualities which invariably elevate their possessors, and ultimately triumph over all obstacles. Workmen who possess such qualifi-

cations are seldom injured by such temporary fluctuations of the labor market as arise from the extending use of labor-saving machinery.

Retributive justice has recently overtaken one of the line officers in our navy who was instrumental in the ruin of the great shipbuilder John Roach. Among the candidates for the vacancy of the Navigation Bureau, caused by the retirement of Admiral Ramsay, was a line officer who was a member of the board which 12 years ago, after the trial trip of the *Dolphin*, declared the vessel to be structurally weak and unfit for sea service. Afterward the *Chicago*, *Boston* and *Atlanta*, which were under construction at Roach's yard, were removed to the Brooklyn Navy Yard and completed by the government. Since that report of the board the *Dolphin* has cruised around the world and in every way proved herself to be an excellent boat. In explanation of that report it is claimed that the naval officers were at that time unfamiliar with steel vessels and ignorant of the extent to which vibration from machinery could be present without indicating structural weakness. But ignorance of this kind is no excuse for the sweeping report which brought to a sorrowful end the career of a great and honored shipbuilder. If our government was entering upon an era of steel shipbuilding it was the duty of naval officers upon whose reports such vessels were to be accepted to become familiar with them. Furthermore, this officer is one who has been active in opposing the just claims of the engineer officers, and has treated their arguments with that contempt which is incompatible with unprejudiced investigation of the merits of this case. Hence, his course of injustice to those in and out of the navy makes it peculiarly fitting that his aspirations should in this case be unsatisfied, and that he should remain in a position where he will do less injury to the righteous cause of the staff officers than he might exercise in the Navigation Bureau. The friends of John Roach and the friends of the engineers in our navy will view with complacency the course of justice.

The Army and Navy Journal suggests to a prominent ex-naval engineer who has actively espoused the cause of the engineers in our navy, that he might turn his attention to foreign navies in a study of accidents at sea, and then goes on to recite the history of several accidents to the machinery of foreign vessels. If we mistake not, the trouble is not with the machinery in our vessels of war but rests with the men who command these vessels. The line officers in their fight against the engineers have augmented their own numbers until it is impossible to give each commander, captain and navigating officer that experience at sea which will make him competent. Hence we have the *Brooklyn* going aground on a ledge as soon as she leaves the builder's yard, and sustaining damages that cost $130,000 to repair, the *Texas* running aground in Newport Harbor, the *Montgomery* scraping the rocks off Governor's Island in New York Harbor, the *Cincinnati* accomplishing the same feat in Hell Gate, etc., etc. And in every case no one is to blame, according to the findings of those remarkable boards of inquiry for which our navy has become famous. When the *Cincinnati* struck something hard at Hell Gate about two years ago, the verdict of the intelligent board of inquiry was to the effect that the something was a submerged wreck, though this finding evidently fails to explain why pieces of rock were found imbedded in her propeller. The submerged wreck excuse worked so well in that case that it was resorted to again to explain why the *Montgomery* got into trouble off Governor's Island last summer. In that case also those who know say that fragments of rock had to be removed from the propeller. We might touch on many other cases to show that the line officers of our navy need more experience in actual service and less protection by boards of inquiry, if our navy is to be an efficient one, but it is hardly necessary to do so when the daily press is constantly supplying evidence in this direction. The people are beginning to understand. A recent issue of Puck holds the navy in ridicule by publishing "a nautical operetta in one act" in which the captain of a U. S. battleship is supposed to receive orders to take his ship to sea, and in attempting to leave the dock the ship runs down a fishing smack, is sunk in the mud and the crew rescued by the fishing smack.

Our line officers may be men of ability, but what is needed is a better organization in our navy: fewer and therefore more experienced line officers, more engineers, a proper recognition of the latter, and no favoritism to anyone. Our vessels may not be perfect, but they are so much superior to our naval organization that it is almost useless to discuss them until the personnel of the navy is reorganized.

THE REJECTED HEAT OF GAS ENGINES.

We publish elsewhere in this number an abstract of a paper on the possibilities of utilizing the heat rejected by gas engines. The author shows that approximately 75 per cent. of the total heat of combustion is discarded by the gas engine, part of it going to the jacket water and the remainder escaping with the exhaust gases. He proposes to utilize this waste heat in one of two ways, to generate steam for steam engines or to heat the building in which the gas engines are placed. Such methods of utilizing waste heat may be possible of execution, but we doubt if they can be made practicable. Gas engines are usually installed because they are more desirable or economical for certain conditions than are steam engines and boilers, and it is hardly conceivable that both steam and gas engines would be installed in the same plant. The first cost of the installation and its inelastic nature, arising from the steam engine being as dependent upon the gas engine as the lower cylinders of a multiple expansion engine are upon the high-pressure cylinder, are both against such an arrangement. To utilize the waste heat for heating the building is more feasible, but at times the heat supplied will be too great, at other times too small, and in summer the heat would have to be discarded entirely.

The further development of the gas engine does not lie in the utilization of its wastes, but in their prevention or reduction. The exact manner in which this desirable end is to be obtained we cannot predict, but it is well to bear in mind that while in the steam engine the enormous amount of heat rendered latent in the working fluid is a barrier to the achievement of any remarkable economies over the best modern practice, there is no such obstruction to progress with the gas engine. In the latter we have to deal with high pressures and temperatures and various difficult problems arising from them, but these are physical and mechanical problems, and, though difficult, they are not by any means to be classed with the impossible. Take, for instance, the loss of heat to the jacket water. At present that loss is great for three reasons; first, the surfaces exposed to the hot gases are usually unnecessarily large; second, the lubrication of the piston by present methods will not permit of any higher average temperatures in the cylinder; and, third, higher average temperatures also give trouble from premature explosion of the charge. To these reasons might be added the statement that much of the heat prevented from going to the jacket would be lost through increased temperature of the exhaust unless ways were devised to utilize it in work on the piston. It is evident, however, that all these matters are largely mechanical problems that will some day be at least partially solved. Take, for instance, the area of the surfaces exposed to the hot gases at the moment of explosion in a 10 by 15 engine; if the clearance is 20 per cent. of the cylinder volume, that space would be represented by a cylindrical chamber 10 inches in diameter and three inches long, the total area of whose surfaces would be 251 square inches. This we may consider as the minimum area which can be reached by good mechanical arrangement of parts. How far many engines fall short of the possible in this direction may be inferred by an examination of the ports and other excrescences on the combustion chamber, by which the total area exposed is sometimes as great as 400 square inches for an engine of the size considered.

The question of lubrication will doubtless be ultimately solved by preventing the gases when at the higher temperatures from

coming in contact with the surfaces whose lubrication is so difficult. This matter of lubrication, together with that of the danger of premature explosion when less heat goes to the jacket, may be solved in part by a better utilization of the heat in work on the piston. The gases are usually at a pressure of from 30 to 50 pounds, when the exhaust valve opens, and are thus deliberately thrown away while their temperatures and pressures are such as to make them capable of doing considerably more work. If exhausted at a pressure as low as would be commercially practicable in view of the size and friction of the engine, the efficiency of the engine would not only be directly increased by the work done and the lower temperature of the exhaust, but by lowering the average temperature of the cylinder, proper lubrication and absence of premature explosion would be possible even when much less heat went to the jacket water, thus producing an indirect gain of no small magnitude.

Every improvement in a gas engine that prevents the waste of heat prior to exhaust raises the pressure of the gases at exhaust and calls for a larger cylinder if the full benefit of the improvements is to be realized. But large cylinders, with high pressures of explosion, call for increased strength and weight throughout the engine, and these influence its first cost and its mechanical efficiency. The fact that successful gas engines have only one working stroke in every four causes the practical limit to enlargement to be reached more quickly than in steam engines. Double-acting engines and single-acting engines with an impulse every revolution have been tried repeatedly, and in general have been failures, but we believe that ultimately they will be made a success, particularly for large powers. The four stroke cycle, because of the simplicity of construction possible where it is used, may never be abandoned for small powers, but when large installations become common we think power will be furnished on more than one stroke in four. If this desirable end is accomplished then the mechanical efficiency of the engine may be increased, and the cylinders can be made large enough to derive the full benefit of improvements in thermal action without overstepping the bounds of practicability. The construction of a satisfactory impulse-every-revolution engine is not easy; Mr. Dugald Clerk, a high authority who has spent many years upon it, says it is one of the most difficult mechanical engineering problems of which he has knowledge; but a search after the possibilities of improvements in the thermal action of gas engines shows so clearly the commercial limitations placed upon the engineer by the four-stroke cycle that one is driven to the belief that at some stage in gas-engine development it will be abandoned for a shorter cycle.

It is impossible to go over the whole field of gas-engine construction in a single article, but we have said enough to show that engineers have before them many channels in which they can labor for the improvement of the gas engine, and which promise far better results than to place it tandem with a steam engine.

SALT-WATER FEED FOR WATER-TUBE BOILERS.

It has been the general belief of engineers far years that salt-water feed could not be successfully used for any length of time in water-tube boilers, because of trouble from priming and the rapidity with which the tubes would be stopped up. But leaky condensers are not entirely unavoidable, and when they do leak, salt water must be used in the boilers until they are repaired or the vessel is without power and helpless. While this argument has applied to all water-tube boilers and has undoubtedly been one of the factors in the prevention of their general introduction on large ocean-going vessels, it has been used with special force against propositions to employ in large vessels the small-tube or "express" boilers. The small tubes of boilers of this class give them great advantages in the way of quickness of steaming, light weight and great capacity, but evidently if salt feed will give trouble at all, it will produce it more quickly in small tubes than in large ones. Under the pressure of these views the use of the small-tube boilers has been confined chiefly to torpedo boats and destroyers, where the enforced reduction of weight made their use imperative.

But the demand in both naval and merchant marine construction for a reduction in the weight per horse-power of engines and boilers, either to permit the use of more power in a boat or to utilize the saving in weight and space for other purposes, has led to some notable installations of the large-tube water-tube boilers. Perhaps the most striking case has been the 25,000 horse-power of Belleville boilers put into the new British cruiser *Powerful* and her sister ship. And now Mr. Yarrow, the well-known builder, comes forward with the results of experiments conducted by him on the use of salt-water feed in Yarrow boilers. He took a second-class torpedo-boat 86 feet long and of 15 tons' displacement, fitted with a Yarrow boiler and triple-expansion engines of 250 horse-power, giving the boat a speed of 17 knots, and ran it successfully many trips of from 4 to 8½ hours' duration, using salt-water feed. The boat would leave the yards of Yarrow & Company with its condenser in operation and everything normal until it was out of the river and running in sea water of average density; then the main feed would be shut-off and the feed from the sea started and kept going until the density rose to figures ranging from 1½/32 to 4⅝/32; then the main feed and the sea feed would be employed alternately to maintain the density, and under these conditions the boat would steam at full speed from 7½ to 8½ hours. In six trials, whose logs are published, the troubles from priming were practically nothing and the deposits in the boiler were slight. An account of one trip, with newspaper representatives on board, says that there was a little priming when the sea feed was first started, but that it quickly stopped, and in 4½ hours of steaming at full speed, using salt feed all of the time, the working of boiler was very satisfactory.

From these trials it would appear that "express" boilers can be made to operate successfully for many hours in case of a break-down of a condenser, and thus one argument against their use in large boats is exploded. The Engineer, in commenting on the trial, says: "We see no reason to doubt that if the Yarrow boiler were worked with sea water, and properly blown down and scummed, it could be run for a month without trouble; whether equally satisfactory results could or could not be obtained with other water-tube boilers we are not in a position to say. Each type of boiler will have to be made the subject of special experiment. The important fact with which we have to deal is that boats fitted with the Yarrow straight-tube boiler can be run up to three-quarter speed at all events with sea water. Of this there can no longer be any doubt."

Another conservative opinion illustrative of the changed opinions towards these boilers is furnished by Engineering, which, in a recent issue, while dealing editorially with a discussion in Parliament on the navy estimates, says: "The small-tube or express boilers of the Thornycroft or Yarrow type have done so well in the torpedo-boat destroyers that confidence in them has been greatly strengthened of late. The work required from a boiler in torpedo craft is of a very trying nature, and though the vessels themselves are small, the power of their machinery is great. For instance, at full speed a torpedo-boat destroyer's engines exert as much power as the *Powerful's* engines do when the latter vessel is steaming at her economical speed, and some of the latest torpedo-boat destroyers now under construction will have machinery not far from one-third as powerful as that of the big cruiser. On another page we give an account of trials made with a Yarrow boiler which should do much to inspire confidence in this type of steam generator, and it may be remembered that the *Speedy* has now been in commission for four years with Thornycroft boilers, which have been remarkably successful. When one remembers the immense saving in weight which is gained by the use of the small-tube boilers, and the many advantages in other respects, it is difficult to resist the conviction that they will make their way to the front, and we shall see them not only in war vessels, but in nearly all vessels in which high speed is a leading feature in the design. Probably it will be found that between the return-tube boiler and the express boiler there will not be much room for the large-tube variety, unless some new departure and great improvement be introduced."

NOTES.

The students of the department of mechanical engineering of the University of Illinois, under the direction of Prof. L. P. Breckinridge, are about to begin a series of locomotive tests on the Illinois Central Railroad. The engines selected for test are two 18 by 24 and four 18 by 26 passenger engines, one 19 by 26 mogul freight engine and one 21 by 24 consolidation engine.

Press dispatches state that there is bad news about Bazin's famous roller steamboat which was expected to revolutionize marine architecture. The recent trial trips at Roen have been discouraging, the engines not proving powerful enough. Their force was trebled, but the increased weight submerges the rollers deeper than is judicious, and they only turn ten times a minute, instead of forty. The rollers throw up such quantities of water behind that it acts like a brake and reduces the expected thirty knots an hour to six or seven. Rubber scrapers are being experimented with to prevent the upheaval of the water.

The elaborate experiments by Germany to ascertain the best colors for warships have led to the conviction that olive green, which is favored by the United States Navy in time of war, is the best, because it renders ships last visible to an enemy. It is true that dark brown has great advantages by day, but there is no doubt that olive green is the hardest to make out at night. During the rebellion of the rebellion of the Brazilian fleet under Admiral Mello in 1894, the loyal ships were painted, olive green, which enabled the torpedo boats to approach the rebel flagship *Aquidaban* within 400 yards undetected and destroy her.—New York Sun.

Superintendent Charles Selden, of the B. & O. Telegraph, said the other day that the average number of messages handled every day on the B. & O. system was 53,000, exclusive of train orders. The B. & O. has 22,252 miles of telegraph wire, of which they use 7,240 for company's business and the balance is leased to the Western Union. There are 384 telegraph offices on the line of which 234 are reporting Western Union offices. Mr. Selden employs in his department 750 men, exclusive of linemen. He also has charge of the block signal offices which east of the Ohio River average one to every six miles. The service of the company's plant is considerably augmented by the use of several multiplex systems.

The acme of German shipbuilding is represented by the new German express steamer *Kaiser Wilhelm der Grosse*, built at the Vulcan Works, Stettin, and it would appear that the new vessel will prove no unworthy compeer to the splendid boats now crossing and re-crossing the Atlantic. The ship indicates about 28,000 horse-power, providing for a minimum speed of 22 knots. The chief dimensions are, between perpendiculars 625 feet, 66 beam, and 43 feet molded depth. The twin-screw engines are of the four-cylinder triple-expansion type, with cylinders of 52, 90, and two of 97 inches diameter, with a stroke of 69 inches. The *Kaiser Wilhelm der Grosse* is considered the finest vessel ever built in Germany.—Industries and Iron.

It is understood that as the result of experiments recently made at Woolwich and elsewhere, the British government has decided to materially reduce the proportion of nitro-glycerine at present employed in the manufacture of cordite. The proportion now being used is 58 per cent., which is much higher than that used by any other government. Mr. Maxim, we believe, prior to taking out his patents, experimented with smokeless powders, containing up to 60 per cent. of nitro-glycerine, and after some 5,000 trials selected a proportion of 16 per cent. as giving the best results as combined with safety and stability. It is obvious that any nitro glycerine powder must necessarily be a compromise, but the safety margin the government has chosen appears to be very small.—Industries and Iron.

If we can credit the European despatches in the daily press there is a possibility of the steam turbine for marine purposes being given a trial on a large scale. Those despatches state that it has been freely rumored at Newcastle-on-Tyne that the Cunard company's engineers are thinking of trying the new marine turbine system on their next steamer. The system was referred to in these columns. Further trials have recently taken place with the little steamer *Turbinia*, with the result that she showed a mean speed on a measured mile, at the mouth of the Tyne, of 32¾ knots an hour, with remarkably low coal consumption. The experts have reported that, although heavy seas were encountered, "there was no racing of screws and the machinery worked with perfect smoothness and complete absence of vibration." The *Turbinia* is only 100 feet long and 9 feet beam, with a maximum displacement of 42 tons.

The Baltimore & Ohio Railroad Company has decided to inaugurate on May 1 the tonnage system for handling its freight trains. For the past eight or nine months General Manager Greene has been experimenting along this line, and has arrived at the conclusion that the cost of operation may be decreased to some extent by using this plan. It is not expected that a very great gain will be made as the B. & O. for the past year has been loading very close to the limit. The unit system will be the basis for operation on the tonnage system, the unit of weight being 6½ tons. When cars are loaded or received from other lines, the number of units of weight it contains will be plainly marked on the side of the car, so that the trainmen will have no difficulty in arriving at the proper number of units to place in the train. The use of the unit system renders it very easy for trainmen to figure on just how many tons they are handling and does away with the use of five and six figures in addition.

At a meeting of the Civil Engineers' Society of St. Paul, held April 5, some data were presented on the shearing value of wire nails in pine planks obtained from tests made at the State University. The general results of about 200 tests of the various sizes of nails, in white and Norway pine, were given. A white pine joint held by one 6d. nail begins to yield at about 70 pounds of shear and gives way at about 160. Held by a 60d. nail, the corresponding figures are 370 and 820, the maximum figure in all cases being about twice that which indicates the point of yielding. Roughly the strength of the joint is the cube of the diameter of the nail into 50,000. The largest nails can be driven 1½ inches center to center, and nearly the full value of the nail is effective. For instance, the result from one 50d. nail to the joint was 347 and 800, while the average of nine 50d. nails to the joint was 294 and 790 per nail. These experiments will be extended and the results tabulated and digested, and at a future meeting of the society will be discussed.

It appears clear that in a few more years we shall have to look beyond Bilbao for the six millions or so of tons of ore we are now annually importing from Spanish territory. Professor Windsor Richards pointed out three years ago that the Bilbao mines were becoming exhausted. The recent visit of the Iron and steel Institute to Bilbao has aroused some notice of this important fact among those interested in the American ore and iron industries, who are confidently predicting that during the course of the next five or six years a great change will come over the comparative circumstances of iron and steel production. While the ore supply of Great Britain is failing, America, it is pointed out, has ore resources whose extent and duration are both at present incalculable; while English ores are growing dearer, those of America are growing cheaper, with the certain result, as one influential organ puts it, "that cheap coal. coke and iron ore together are likely, in the next five years, to put American iron products in a position that will vindicate the policy of protection before the world."—*Industries and Iron (London)*.

From the accounts of a series of tests of the accuracy of the Le Chatelier pyrometer made by Doctors Holborn and Wier, in the government physical laboratory, at Charlottenburg, and published in the Magazine of the Austrian Engineers' and Architects' Society, it appears that it is possible to record temperatures up

to 1,800 degrees C. with a limit of error of one-half of 1 per cent. In standard of accuracy was an air thermometer. The Le Chatelier pyrometer consisted of a thermo-electric couple and a galvanometer. The thermo-electric couple was formed by two wires enclosed in a glazed porcelain tube. One wire was of platinum and the other an alloy of 90 per cent. platinum and 10 per cent rhodium. The tube was one meter long and 35 millimeters (1⅛ inches) in diameter and the wires within were, of course, insulated for their entire length, except at one end where they joined. The electric current generated by the couple is proportional to the temperature, and was measured by a galvanometer with stationary permanent magnet and a movable coil, and which was wound specially for the detection of feeble currents.

The Navy Department will soon receive bids for the construction of two 30-knot torpedo boats and one destroyer of 31 knots, the latter to be one of the largest boats of her class constructed for the navy. The other two will be smaller, and much like the boats now building at Bath and the Union Iron Works. The department will also contract for the building of a steel composite practice ship for the naval cadets, on the design of the *Newport*, now nearing completion at Bath. This ship will have ample supply of sail power, will be clipper built, and of 13 knots speed. She will cost when in commission nearly $300,000, and will be one of the best boats of her class commissioned. Capt. Cooper, Superintendent of the Naval School, who appears to belong to that class of line officers who have not yet waked up to the changed conditions brought about by the introduction of steam power, has opposed the building of a steam and sail ship, and believes that a simple sailing vessel without steam power is better adapted for use in instructing cadets in practical seamanship. His views have not been approved, however, by the naval authorities, who believe that the days are past when sail power will ever be important in propelling war vessels, and that young officers should be exercised on vessels similar, as far as possible, to those they will have to command. The authorities would have been blind indeed if they had arriyed at any other conclusion after the incapacity which some officers of the sailor class exhibit on board our modern steamships.

The Great Eastern Railway Company, which has been doing smart work of late in replacing some of their bridges which span rivers in a single night, beat its own record recently, when, in spite of a severe snowstorm, the bridge over the River Lea to the south of Tottenham station, on the main line, was replaced by a new bridge, the old one being removed and the new one placed *in situ* in nine hours. The old bridge was removed and the new one put in its place by the same process and at the same time. Mr. Wilson, the Chief Engineer, with a large body of officials, and gangs of men to the number of 70, were on the bridge soon after midnight with a huge crane, several crabs, a couple of 100-ton jacks and several 50-ton jacks in reserve. At 12:30 a. m. operations were commenced. The first thing to do was to strip the rails from the old bridge, taking up the planking as well as the permanent way, in order that the lifting apparatus could be attached to the girders to raise the whole bridge bodily to the extent of 18 inches. This was to allow of trolleys being placed underneath resting on transverse girders, which had been erected so that the bridge, being elevated on wheels, could be drawn away. The old bridge was 77 feet in length. The new bridge, 84 feet 9 inches in length, had been erected beside the old one, complete even to the rails and its final coat of paint. It had already been provided with temporary wheels to facilitate shifting. The preliminary part of the work—the raising of the old bridge and placing it on wheels—was the most arduous part of the task, and occupied the men incessantly until a quarter to seven. Then, by means of powerful crabs and winches attached to the new bridge, this was slowly pulled into the place of the old, the latter being at the same time pushed out of the way. It was a dead weight to move of 250 tons, but it was accomplished in an hour. At a quarter to eight the new bridge was in its place, and the old bridge was by its side. The next thing to be done was to remove the trolleys or wheeled carriages from under the new bridge and lower it into its final position flush with the permanent way. The completing of this occupied the remainder of the morning, and then the leveling up and adjusting was gone on with; but at 2:20 the engineer's train was able to cross the new bridge, and the work was practically completed.—*Engineering.*

Personals.

Mr. E. L. Russell has been elected Vice-President of the Mobile & Ohio.

Mr. T. J. James has been elected President of the Wadley & Mt. Vernon Railroad.

Mr. Frederick K. Ulman has been appointed Receiver for the Brooklyn Elevated road.

President James Shannon, of the Fonda, Johnstown & Gloversville Railroad, died on March 12.

Mr. Robert Hancock has been elected President of the Atlantic & North Carolina Railroad Company.

Mr. G. A. Nettleton, Chief Engineer of the Ann Arbor road, has resigned, and is succeeded by Mr. O. D. Richards.

Mr. I. W. Troxell has been appointed General Manager of the new Queen Anne's Railroad. Office, Queenstown, Md.

Mr. Thomas Fisher has been appointed Receiver of the Roaring Creek & Charleston, to succeed Mr. C. T. Dixon, resigned.

Mr. M. W. Wilkins is President of the New Albany, Lebanon & Sodaville road in Oregon. Headquarters Waterloo, Ore.

Mr. L. J. Polk, Acting General Manager, has been formally appointed General Manager of the Gulf, Colorado & Santa Fe.

Mr. E. B. Cushing has been appointed Chief Engineer and General Superintendent of the Houston, East & West Texas.

Col. John Magee has been elected President of the Fall Brook Railroad, to succeed his father, the late Gen. George J. Magee.

Mr. Frederick W. Kruse, of Olean, Pa., has been appointed Receiver of the Allegheny & Kinzua road, vice Mr. A. D. Scott.

Mr. David S. Hammond, Treasurer and Purchasing Agent of the Cornwall Railroad, died at his home in Lebanon, Pa., on April 3.

Mr. Charles A. Beach, formerly General Superintendent of the South Jersey Railroad, has been appointed General Manager of the company.

Mr. J. F. Sheahan, Master Mechanic of the Fourth and Sixth divisions of the Plant System, with headquarters at Palatka, Fla., has resigned.

Mr. F. A. Horsey, of New York, has been elected President of the St. Louis & Cairo Railroad Company, to succeed his brother, the late J. H. Horsey.

Mr. W. H. Marshall is appointed Assistant Superintendent of Motive Power and Machinery of the Chicago & Northwestern Railway, with office at Chicago.

Mr. F. F. Gaines has been appointed Mechanical Engineer of the Lehigh Valley's motive power department, vice H. D. Taylor, promoted. Office at South Easton, Pa.

Mr. H. Ridgeway has been appointed Master Mechanic of the Chihuahua Division of the Mexican Central, with headquarters at Chihuahua, to succeed Mr. T. Smethurst.

Mr. H. A. Whiting, Vice-President and General Manager of the Wilmington, Newbern & Norfolk, has been appointed Receiver of that road, with office at Wilmington, N. C.

Mr. Joseph H. Sands has resigned as General Manager of the Norfolk & Western, and the duties of that position will hereafter be performed by Mr. J. M. Barr, Vice-President.

Mr. John Echols has retired from the position of President and General Manager of the Chesapeake, Ohio & Southwestern, owing to the absorption of that road by the Illinois Central.

Mr. James N. Hill, Vice-President of the Eastern Railway of Minnesota, has assumed the duties of General Manager, with headquarters in Duluth, vice Mr. W. C. Farrington, resigned.

Mr. G. W. F. Harper, formerly President and Treasurer of the Chester & Lenoir Railroad Company, has been elected President of the reorganized company, the Carolina & Northwestern Railroad.

Mr. T. C. Sherwood, formerly Assistant General Manager of the Kansas City, Pittsburgh & Gulf, has been appointed General Manager of the Kansas City & Northern Connecting, with headquarters in Kansas City.

Mr. S. C. Dunlap, of Gainesville, Ga., has been appointed permanent Receiver for the Gainesville, Jefferson & Southern Railway, succeeding Mr. Martin H. Dooly, who was appointed temporary Receiver some weeks ago.

The office of Master Mechanic of the Dunkirk, Allegheny Valley & Pittsburg, made vacant by the death of Mr. W. G. Taber, has been abolished. Mr. A. Sherman has been appointed Foreman of the shops at Dunkirk, N. Y.

Mr. J. F. Dunn, formerly Master Mechanic of the Union Pacific at Pocatello, is Superintendent of Motive Power of the Oregon Short Line and Mr. Ira O. Rhodes, assistant to the Purchasing Agent of the Union Pacific, is General Purchasing Agent.

It is reported, on apparently good authority, that Mr. Daniel S. Lamont will become President of the Northern Pacific, in case of the retirement of Mr. Winter, which is made probable by the new relations between that company and the Great Northern.

Mr. E. L. Martin, President of the Kansas City, Pittsburgh & Gulf Railroad, has resigned. Mr. A. E. Stillwell, Vice-President and General Manager, has been chosen to succeed him. Mr. Martin had been President of the road since it was first organized in 1890.

Mr. O. R. Fyler has been nominated to succeed A. C. Robertson of the Connecticut Board of Railroad Commissioners, whose term expires on July 1, and Mr. W. F. Wilcox has been nominated to succeed Mr. George M. Woodruff, whose term expires on the same date.

Mr. George Masson, for the past 12 years Chief Engineer of the Chicago & Grand Trunk, Detroit, Grand Haven & Milwaukee, and other Grand Trunk lines west of Detroit, has been retired under the policy of consolidating the engineering department of the Grand Trunk system.

Mr. George F. Foster has resigned as Master Mechanic and Acting Trainmaster of the Lexington & Eastern, and the offices have been abolished. Mr. E. R. McCuen has been appointed General Foreman in charge of the mechanical department, with headquarters at Lexington, Ky.

Benjamin Butterworth, of Ohio, has been appointed Commissioner of Patents by President McKinley. General Butterworth held the office once before and there is good reason to look forward to an intelligent and efficient administration of the affairs of the department under his management.

Mr. Albert Foster, Purchasing Agent of the Philadelphia & Reading, died in the Continental Hotel in Philadelphia on April 10. Mr. Foster entered the employ of the Philadelphia & Reading in 1858, and remained with that company until the time of his death. He has been Purchasing Agent since 1890.

Mr. John Hickey, recently Superintendent of Motive Power of the Northern Pacific, had been residing in Denver, where his health has greatly improved. He has now been appointed General Master Mechanic of the Rio Grande Western. This will take him to Salt Lake City, where the climatic connitions are about the same as at Denver.

Mr. W. G. Nevin, General Purchasing Agent of the Atchison, Topeka & Santa Fe, with headquarters in Chicago, has been appointed General Manager of the Southern California, to succeed Kirkland H. Wade, deceased. Mr. Nevin's headquarters will be at Los Angeles, Cal. He has been succeeded as General Purchasing Agent of the Atchison, Topeka & Santa Fe by Mr. W. E. Hodges.

The following changes have gone into effect on the Grand Trunk: Mr. J. W. Harkom has been appointed Master Mechanic for the Eastern Division, with headquarters at Montreal. Mr. W. D. Robb has been appointed Master Mechanic for the Middle Division, with headquarters at Toronto. Mr. William Ballh as been appointed Master Mechanic for the Northern Division, with headquarters at Allandale, Ont.

John King, formerly President and later Receiver of the Erie Railway, died at Beaulieu, near Nice, France, March 17. Mr. King began his railway career on the Baltimore & Ohio, where he finally rose to the position of Vice-President and President *pro tem.* Later he accepted the Presidency of the Pittsburg & Connellsville Railway, and afterward was Receiver of the Marietta & Cincinnati and the Ohio & Mississippi companies. In 1894 he was elected President of the Erie road, and displayed great ability in reorganizing its affairs.

As a result of the death of Mr. Joel West the following appointments on the Chicago, Burlington & Quincy were announced on April 5: C. W. Eckerson, Master Mechanic East Iowa Division at Burlington, vice Joel West, deceased; J. F. Deems, Master Mechanic St. Louis Division at Beardstown, vice C. W. Eckerson, promoted; J. E. Button, Master Mechanic East Iowa Ottumwa Division, vice J. F. Deems, promoted. Four days later Mr. Eckerson died suddenly of heart disease while on a train that was leaving St. Louis. Mr. Eckerson had been connected with the Chicago, Burlington & Quincy Railroad for 27 years.

Joel West, Master Mechanic of the Iowa lines of the Chicago, Burlington & Quincy road at West Burlington, Ia., died at Los Angeles, Cal., on the 23d instant, of Bright's disease. Mr. West entered railway service in 1856 as a machinist on New York Central road. He went to the Burlington road in 1857 as a machinist at Quincy, Ill., and became General Foreman the following year. In 1863 he was appointed Master Mechanic of the Galesburg & Quincy and Burlington & Quincy branches, and in 1876 he became Master Mechanic of the Iowa lines of the same road, which position he held at the time of his death.

New Publications.

THE MATERIALS OF CONSTRUCTION. A TREATISE FOR ENGINEERS ON THE STRENGTH OF ENGINEERING MATERIALS. By J. B. Johnson, C. E. John Wiley & Sons, New York; Chapman & Hall, Limited, London. 1897. 800 pages.

In this work Professor Johnson has analyzed and summarized much of the best work done at home and abroad in the direction of establishing fixed laws and principles in the realm of the strength of materials, and has drawn largely upon the works of Bauschinger, Tetmajer, Martens, the reports of the recent French Commission, the records of the tests of the U. S. Test Board and of Mr James E. Howard at the Watertown Arsenal, the series of tests on cements, mortars and concretes at the St. Mary's River canal locks, Kirkaldy's reports and the results of the U. S. timber tests and investigations.

The book is divided into four parts: First, a synopsis of the principles of mechanics underlying the laws of the strength of materials; second, the manufacture and general properties of the materials of construction; third, the methods of testing the strength of materials; fourth, the mechanical properties of materials of construction as determined by actual tests.

In Part I. the behavior of materials under tensile, compressive and bending stresses, etc., are considered. The laws governing the crushing strength of brittle materials are shown for the first time in English. In this part also the resilience of materials is much more fully treated than is commonly done.

In Part II. the methods of manufacture of cast iron, wrought iron, steel, the alloys, cements, and paving brick are each treated very fully, and in addition a chapter of 100 pages is devoted to a scientific and systematic description of timber and timber trees such as has never before been brought together in such a work. The recent Forestry Division investigations on timber, with which Professor Johnson has been so intimately associated, furnish most of the data for this chapter.

In Part III. are described the most approved forms of testing appliances and methods of testing materials. The four large volumes comprising the recent (1895) report of the French Commission, and

the proceedings of the five international conventions on the subject of standard methods of testing materials (Munich, 1885; Dresden, 1886; Berlin, 1890; Vienna, 1893, and Zurich, 1895) have been as freely drawn upon as practicable without destroying the unity of the treatment.

In Part IV. are given graphical representations (stress-diagrams) and text descriptions of the most significant results of tests of all kinds of structural materials made in all parts of the world. Professor Johnson has for the past 12 years been a special student in this direction, since in his capacity as Director of the Testing Laboratory of Washington University, St. Louis, it was his business to inform himself on all such matters, and his many sources of exact information have given this part of the book great practical value. Here also are given a summary of the results of the remarkable series of tests of American timbers (still incomplete), the tests being some 40,000 in number, on 32 species of timber, all of which tests and reductions were conducted by the author of this work in his own laboratory during the past six years.

The magnetic properties of iron and steel, and the methods of determining them, have been incorporated in a valuable chapter written for the author by an electrical engineer. In appendices are given a biographical sketch of Prof. Johann Bauschinger, an excellent account of the microscopic study of iron and steel, by Prof. J. O. Arnold, of Sheffield, Eng.: a synoptic comparison of the recommendations of the international conventions with those of the French Commission, and three sets of specifications for iron and steel for various purposes.

It will thus be seen that the author has produced a book of unusual value to engineers, and from its appearance the publishers have evidently spared no expense in its publication.

THE ELEMENTARY PRINCIPLES OF MECHANICS. Vol. II. Statics By Prof. A. J. DuBois. John Wiley & Sons, New York; pp. 392.

The author says, "The large type by itself constitutes an abridged course, etc." This is a good way of making a large book serve for a smaller one as well as for a larger one; but as we glanced over it we failed to see the distinction in the type that is indicated by the "note." Certainly the difference, if any, is not striking.

There is one attempt at classification both in the headings and in definitions. The title of the book is "Statics," but on the first page of the body of the book the heading is "Dynamics." On page 2 Dynamics is defined, and that heading is carried to page 56, although the discussions for more than 50 pages do not conform with the definition. On page 57 "Statics" is defined and this heading is carried to the end of the work; but problems involving planetory motions, pp. 124, etc., seem to be strangely out of place according to the definition and our ordinary sense of "Statics." Chapter I, p. 228, begins with "Applications," but the distinction between the character of the subjects before and those which follow is not very marked.

There is an effort at nice discrimination in definitions, and some are excellent; but it is questionable whether such refinements would lead one to say that the "direction and speed are changed by the action of another particle." We say so in popular language without being challenged, but we now refer to a critical knowledge of mechanics. Is it not "force" which changes speed and direction On page 7 we read, "When one body presses another it is itself pressed by this other with an equal force in an opposite direction." It says "equal force," and we ask, equal to what? The author might appeal to Newton for authority—who said, "If I press a stone with my finger, my finger is pressed equally by the stone." It seems to us that these statements are not properly discriminating. We should say, if I press a stone with my finger a force is developed between my finger and the stone, which force acts equally in opposite directions. *Every force* acts equally in opposite directions. Laplace said: "That peculiar modification by which a body is transported from one place to another is, and forever will be, unknown—we call it force." More briefly, force is an action between bodies. We learn its laws—at least some of them—and learn to apply them.

"When g must be taken for the locality in feet per second per second." It is so common to retain the same unit throughout a discussion that it seems unnecessary to repeat the "per second." If one is liable to change the unit of time, may he not change the lineal measure—say, inches. It would, at least, sound odd to say feet per second per inches per minute. If the author considered it advisable after once writing the expression in full to say that where the second is once named it will be understood as the unit of time used throughout, it would be unnecessary to repeat the "per second."

In a mathematical work the expressions "manifestly," "evidently," "of course," are usually blemishes. They add nothing to the argument or explanation, and sometimes are seemingly used to avoid explanations. This work is comparatively, though not entirely, free of them.

On pages 320–321 are twelve numerical examples to be found in Merriman's Mechanics of Materials; on page 363 eight examples from Wood's Resistance of Materials; pages 256–262 are much like Merriman's Retaining Walls and Masonry Dams; these, and others, are not credited. It is a delicate question to say how much work of others may be used without credit. It is said that the contemporaries of Laplace complained of that eminent man for utilizing their productions without credit. The action did not heighten their estimate of the man.

But none of these things affect the essential merits of the book for a student. The student can obtain from it a good knowledge of the subject. The applications are numerous, many of which are fully worked out and a sufficient number unsolved to test the knowledge and ability of the reader.

ELECTRIC POWER TRANSMISSION. A Practical Treatise for Practical Men. By Louis Bell, Ph. D. The W. J. Johnston Company, New York, 1897. 491 pages; $2.50.

The author states in his preface that this volume is designed to set forth in the simplest possible manner the fundamental facts concerning present practice in electrical power transmission. He endeavored in introducing such theoretical considerations as are necessary to explain them in the most direct way practicable, using proximate methods of proof when precise and general ones would lead to mathematical complications without altering the conclusion for the purpose in hand, and stating only the results of investigations when the processes are undesirably complicated. In writing of the many-sided and rapidly changing art, it is impossible in a finite compass to cover all the phases of the subject or to prophesy the modifications that time will bring forth; hence the epoch of this book is the present, and the point in view chosen is that of the man, engineer or not, who desires to know what can be accomplished by electrical power transmission, and by what processes the work is planned and carried out.

The first chapter is devoted to elementary principles and is to be commended for the clearness of its style. In the second chapter the general conditions of power transmission are considered, electric, wire rope, hydraulic, compressed air and gas transmission being discussed. Power transmission by continuous and alternating currents is next taken up, and in a chapter devoted to "Current Reorganizers," commutators, motor dynamos and rotary converters and transformers are considered. Chapter vii., on "Prime Movers" is almost wholly devoted to steam engines and water wheels, other prime movers being used so infrequently as to require no attention in a work of this kind. Chapters on hydraulic development, the organization of a power station, line construction, centers of distribution and the commercial problem conclude the work. The last-mentioned chapter presents the cost of horse-powers from steam and water-power, the various other costs such as interest, depreciation, labor, supplies and maintenance, and such items as are needful in determining whether a proposed power transmission plant will pay.

The author's style is clear and concise, and the book will undoubtedly be very favorably received.

Books Received.

STATISTICS OF THE RAILWAYS OF THE UNITED STATES, 1895. The Interstate Commerce Commission, Washington, D. C.

COMMERCE AND NAVIGATION OF THE UNITED STATES, 1896. Volume II. Bureau of Statistics, Treasury Department, Washington, D. C.

Trade Catalogues.

[In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. These are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

CATALOGUE NO. 24 OF THE PEERLESS RUBBER MANUFACTURING CO., 16 Warren street, New York. 120 pages, $5\frac{3}{4}$ by $8\frac{1}{4}$ inches (Not standard size.)

This neat and attractive catalogue presents an imposing array of mechanical rubber goods, and is believed to be one of the most

complete lines of such goods offered to the trade. In the earlier pages of the catalogue is described various kinds of packing, the first of which is "Rainbow" packing, a sheet packing adapted for air, steam or water joints, unaffected by oils, ammonia, liquors or alkalies, and does not harden or crack. The company has sold over 4,000 tons of this packing in the last five years. "Eclipse" tubular gaskets is another of the company's products that has been favorably received everywhere. One great convenience in its use is that one can promptly make any size of gasket without waste of material. The Peerless piston and valve-rod packing has a round red rubber core covered with soft loosely woven duck impregnated with plumbago. It will hold 400 pounds of steam. It is made in various sizes and styles. The graphite pump packing, made especially for Westinghouse pumps, is well known to our readers. The company also makes a square braided flax rod packing and an excellent hydraulic packing.

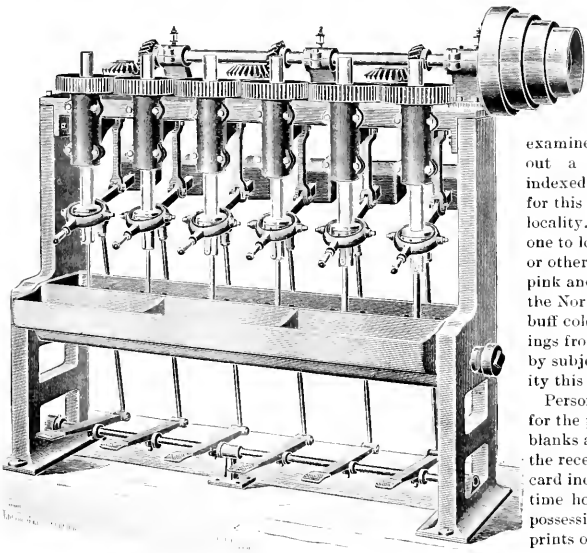
"Rainbow" rubber belting is listed in all sizes up to 60 inches in width and 8-ply in thickness. The very best of material and workmanship enter into its manufacture. "Durham" and "Peerless" are other well-known brands of this company's belting. The section of the catalogue devoted to belting contains many valuable suggestions on the care of both rubber and leather belting. The company produces leather belting too.

The line of rubber hose manufactured by this concern is a large one, and our readers are aware of its excellence. It includes engine and tender hose, air brake hose, signal hose, steam hose, hot water hose, fire hose, etc., etc. Thirty pages are needed to describe and illustrate the many kinds. Other goods listed in this catalogue include rubber mats of all kinds, landing pads, gage glass rings, pumps valves, hose pipes, rubber fire buckets and pails, gas bags, tubing, rubber cement, rubber springs, rubber mallets, wringer rolls, etc.

It would be a superfluous for us to dwell on the excellence of these goods, for the company has achieved its present high reputation through its policy of making nothing but the best.

The Acme Nut Tapper.

The Acme Machinery Company, Cleveland, O., the well-known manufacturers of bolt, nut and special machinery, are the builders of the nut-tapping machine which we show in the accompanying engraving. They build them with either four or six spindles, as



The Acme Nut Tapper.

may be desired, and in three sizes; the smallest size will drill holes from 3/8 inch to 1 inch in diameter, the next size from 1/2 to 1 1/2 inches, and the largest size from 1/2 to 2 inches in diameter. The spindles are arranged to be driven in pairs and the pairs can be run at different speeds or all at the same speed. The driving mechanism is extremely simple and the spur and bevel gears are all cut from the solid, insuring a smooth and practically noiseless running of the machine. Quick-acting spring sockets are used, so that the machine need not be stopped for the removal or insertion of the taps.

The Acme Machinery Company makes a specialty of bolt cutters, nut tappers, bolt headers and forging machines, and their machines are well designed and equally well built. Their catalogue describes a great variety of the machines of this class turned out by them.

Norfolk & Western Notes.

In visiting the headquarters of the mechanical department of a railroad company it is usual to devote much attention to the shops and the machinery, special devices and methods employed in them. We feel, however, that if in briefly describing what we saw on the occasion of a recent visit to Roanoke, on the Norfolk & Western Railroad, we confine ourselves chiefly to the methods employed in the administration of the mechanical department, it is only a merited testimony to the excellence and thoroughness of those methods, and no reflection upon the shops.

The office building of the railroad company was burned about a year ago, and a new structure is in course of erection on the site of the first one. In the meantime Mr. R. H. Soule, Superintendent of Motive Power, has his headquarters in a near-by office building. The shops are only a short distance away, and there all the other officers of the mechanical department have their offices, except Mr. Sanderson, Assistant to Mr. Soule, who has an office adjoining his chief.

Our first visit was to the office of Mr. G. R. Henderson, Mechanical Engineer for the company, and we found much to interest us there. The drawing-room work is conducted in a systematic manner. Drawings are made in pencil and then traced on cloth. There are seven standard sizes for drawings ranging from 8 by 11 inches to 36 by 59 inches and these are designated by the letters A to G inclusive. Each tracing when finished is given a serial number prefixed by the letter indicating its size. This letter also indicates the drawer in the fireproof vault in which the tracing is to be kept. Two other letters, H and I, are for miscellaneous drawings received from outside sources, the first embracing those that will fold to 4 by 9 inches for filing, while the last letter is for rolled drawings.

After a tracing is finished the draftsman turns it over to an examiner who examines it in every detail and if correct turns it over to the chief who also examines it in its essentials and when approving it fills out a memorandum by which the drawing is to be card indexed by a subordinate. Printed blanks are provided for this purpose and each drawing is indexed by subject and by locality. This indexing by locality is convenient, for it enables one to look up quickly all drawings pertaining to a certain shop or other point on the line. The card indexing is done on buff, pink and blue cards. All indexing of drawings originating on the Norfolk & Western Railroad are indexed by subjects on the buff colored cards and for locality on the blue cards. All drawings from outside sources which it is desirable to keep are indexed by subject on pink cards, and if it is desirable to index by locality this is done on a blue card. The cards are typewritten.

Persons wanting blueprints order them upon blanks provided for the purpose, and the prints are sent to them with receipt blanks attached, and the parties receiving the prints must fill out the receipts and return them to the office. These receipts are card indexed in such a manner that it can be ascertained at any time how many copies of each drawing are out and in whose possession they are. If a change is made in a drawing all the prints of it are recalled, the card index being consulted for the purpose. New prints are sent out in their place, and these parties, and all others interested, are notified of the change.

An excellent method of filing catalogues also exists in this office. Each catalogue received is carefully examined, and, if considered worth saving, is card indexed. If a leaflet it is put in

a Globe file, but if a book it is placed on one of several shelves that are partitioned off into short sections. These files and shelves are numbered, and each catalogue is marked with the number of the receptacle in which it is filed, so that it can be returned to it readily.

Standard specifications also receive careful attention in this office. Those for materials are printed, but those for equipment are typewritten, as nearly every new order for engines or cars calls for modifications of the previous specifications. Each specification of material receives a number which it retains through all changes that may be made in it. But each time a specification is revised it is given a new letter as a suffix to the number: thus an axle specification might be numbered 18a, but if revised it becomes 18b, and if again altered becomes 18c, and so on. A file of all specifications is kept, in which appears every form of each specification, together with the reasons which led to the changes made and also the source from which the original form of specication was obtained. Thus this file gives a complete history of the standard specifications of the road. A duplicate of this file is kept in Mr. Soule's office for his convenience.

There are a number of the specifications which might interest our readers, but we will refer to one, only because we wish to mention the manner in which the material is tested. This specification is for globes for hand lamps and part of the specification reads as follows:

"Globes must be of clear color and uniform tint. Those having parts or spots of a shade either lighter or darker than the prescribed standard minimum or maximum, or having a cloudy appearance, or showing an improper tint, will be liable to rejection. They must be of approximately uniform thickness, and the globes will not be accepted thinner than three-thirty-seconds of an inch, or thicker than five-thirty-seconds of an inch.

"Manufacturers furnishing colored globes to the Norfolk & Western Railroad Company will be provided with standard minimum and maximum globes.

"Each red globe and about 25 per cent. of all green and blue globes will be tested by the Railroad Company at Roanoke by trial in a standard hand lamp, between the maximum and minimum standards, in a dark range about 100 feet long, and the color and intensity of the inspected globes must come between the standard limits."

The "dark range" in which these globes are tested is about 100 feet long, 3½ feet wide and 1 foot high. It has a small dark room at each end, in one of which an observer is stationed, while in the other the globes are placed over three lights placed in a transverse row. Thus standard maximum and minimum globes and the globe to be tested can all be viewed at once. The inspection is quickly and surely made. When first inaugurated this inspection caused the rejection of many globes but now there is little trouble in this respect only four being rejected in the last shipment of 15 dozen.

The railroad company makes its own cast-iron wheels and careful records are kept of wheel mixtures, tests, and of wheels mounted for service. For this purpose a set of printed blanks for reports are used, the first of which is that on which a daily report of wheels made is sent from the foundry to the mechanical engineers' office. This gives the numbers of the wheels cast, their diameter, the kind of chill and the mixture from which they were cast. Another blank gives all the information regarding wheel drop tests and still another gives the results from test bars. This last blank is ruled so that the result of a test can be expressed diagramatically by drawing freehand one line for unchilled and another line for chilled bars. This is done in copying ink, and it is afterward copied in a letter press in the mechanical engineers' office. Other blanks are provided for reporting weekly from the various shops the wheels mounted and scrapped. From these blanks entries are made in three books in the engineer's office. The principal book is one ruled for the record of 10,000 wheels, the wheels being numbered consecutively. Here the date cast, diameter, kind of chill, date put into service, date removed, etc., is entered. If the wheel never left the foundry, but was scrapped for defects, it is so recorded. If it was broken up for test that fact is stated. In the next book the result of wheel drop tests and the mixtures from which the wheels were cast is recorded, and in the third book the results from the test bars are copied, as already stated. Thus everything pertaining to the history of each wheel is so recorded that it can be found on short notice: furthermore, the results of various mixtures can be intelligently studied.

In Mr. Soule's office one of the first things to attract our attention was the manner in which performance sheets are compiled. The coal records are averaged for classes, and individual engine performances do not appear. This method was adopted some time ago, as it was believed the clerical labor involved in individual engine records was not warranted by the results obtained. The question naturally arises as to how the performances of certain classes of engines in a given service are obtained and compared. This is done by having the coal records of a number of engines in each class under investigation reported to the superintendent for a time sufficiently long to give the desired information. It is argued that this is the only reliable method anyway, as the monthly records of individual engines are being constantly affected by various causes which may be traced at the time, but which are forgotton shortly afterward, thus making old individual records unreliable for such purposes. Both locomotives and cars are given on the one sheet and arranged according to divisions of the road. The various headings are as follows:

ENGINE MILEAGE.

Miles Run in Passenger Service.
Miles Run in Freight Service.
Miles Run in Shifting Service.
Miles Run in Maintenance of Way Service.
Total Engine Mileage.
Average Mileage of Passenger Engines.
Average Mileage of Freight Engines (Shifting and M. of W. included).

CAR MILEAGE.

Passenger Car Mileage.
Freight Car Mileage, Loaded.
Freight Car Mileage, Empty.
Total Freight Car Mileage.
Per Cent. Empty to Total Freight Car Mileage.
Total Freight Car Mileage, on Loaded Basis.
(Two Empty Cars Equal One Loaded.)
Engine Mileage and Car Mileage on Mixed Trains are included under Freight Train Mileage, three passenger car miles (loaded or empty) equal to two loaded freight car miles.

PERFORMANCE OF ENGINES.

(Shifting and M. of W. included under Freight).

Pounds of Coal per Car Mile, Passenger.
Pounds of Coal per Car Mile, Freight.

PER 100 ENGINE MILES.

Pints of Cylinder Oil, Passenger.
Pints of Cylinder Oil, Freight.
Pints of Lubricating Oil, Passenger.
Pints of Lubricating Oil, Freight.

PER 100 ENGINE MILES.

Pounds of Waste for Cleaning and Packing, Passenger.
Pounds of Waste for Cleaning and Packing, Freight.

PER 100 ENGINE MILES.

Cost of Tools, Supplies and Sand (M. E. 11)
Cost of Hostlering, Watching and Cleaning, (M. E. 12).
Cost of Operating Water and Coal Stations, (M. E. 16).
Pints of Oil used in Lubricating Passenger Cars per 100 Miles Run.
Pints of Oil used in Lubricating Freight Cars per 100 Miles Run.
Pounds of Waste used in Packing Passenger Cars per 100 Miles Run.
Pounds of Waste used in Packing Freight Cars per 100 Miles Run.
Cost of Locomotive Repairs per Mile Run.

It was formerly the practice to give coal premiums on this road, but they have been abolished.

The cost of lubricating cars has been brought down to a low figure by persistent effort, and is now .058 per 1,000 miles for passenger cars and .054 for freight cars.

Engine breakdowns when they occur result in such considerable delays that the causes of them have been systematically investigated and recorded. Every breakage of locomotive parts is reported to the mechanical engineer's office, and if necessary the report is accompanied with a sketch. These breakages are tabulated and the record in that form is sent to Mr. Soule's office. If it is shown that certain parts break frequently the cause of the weakness is sought and the remedy applied. The cost of the breakages is also kept, and in 1892 it was $1.28 per 1,000 miles, in 1893 it was $1.19, in 1894 it had fallen to 86 cents and last year it was only 52 cents per 1,000 miles. The number of breakdowns per year per engine was 1.32 in 1894, 1.12 in 1895 and 0.81 in 1896—a truly excellent showing.

Every railroad is called upon to make many trials of devices submitted. It frequently happens that these trials are started and then forgotten in the press of routine business. To prevent this Mr. Soule has established a file of "trial records," in which is recorded the history of every trial of a device. For instance, at a regular meeting of the various master mechanics on the road it may be deemed advisable to give a certain brake beam a thorough trial. It may be furthermore decided that the trial will be made on certain divisions of the road, and that a report will be made at the end of six months. All this is duly recorded in the file of trial records, and periodically this file is examined by the chief clerk and parties notified shortly before reports from them are expected. The file is kept up to date, so that the history of every trial as far as it can be written is found therein. This file is an excellent idea, for if it is worth while beginning the trial of any device it is worth continuing to the end, and having an intelligible and trustworthy record of the results.

The reports of general car inspectors are kept in Mr. Soule's office, also copies of all instruction, issued by them. These instructions, though signed by the inspectors, are in reality prepared at headquarters, as it has been found necessary to take this step.

Mr. Soule has in handy form many important records in his office, such as weekly conditions of freight equipment, condition of passenger cars and engines, stock accounts, etc. An excellent engine board, which ornaments one side of Mr. Sanderson's office, was described in this journal for November, 1896.

The Great Siberian Railroad and the Present State of its Construction.

(Special Correspondence to the *American Engineer, Car Builder and Railroad Journal.*)

(CONTINUED FROM PAGE 140.)

THE CENTRAL SIBERIAN RAILROAD.

The Central Siberian Railroad from Obi River to Irkoutsk, 1,149 miles long, in consequence of the varying character of the country, is divided into two divisions, viz. :

The first division from Obi River to Krasnoiarsk, having 474 miles of main line and 3 miles of branches.

The second division from Krasnoiarsk to Irkoutsk, having 675 miles of main line and 3 miles of branches.

Besides them to the first division belongs a large branch from Taiozhnaia Station to Tomsk, 59 miles long.

In February, 1893, the Emperor decided that the construction of the Central Siberian Railroad should be begun, and the work was commenced in the same year. The track laying on the first division was completed in December, 1895, and it was opened for traffic in October, 1896. The branch from Taiozhnaia to Tomsk (59 miles long) was begun in July, 1895, and the track-laying was completed in September, 1896.

The cost of construction of the first division (474 miles), was estimated, without rolling stock, at $12,500,000: but this sum was not sufficient, and a supplementary assignment of $1,750,000 was required, so that the full cost of first division (without rolling stock), is $14,200,000, or about $30,000 per mile. The branch to Tomsk is estimated about $1,000,000.

In autumn of 1896 the first division, together with the branch to Tomsk, was opened for traffic, and was nearly complete, excepting a few works, which will be finished in spring, 1897. These works are: The finishing of the slopes of grading, the draining in marshy grounds, the laying of 30 per cent. of switches and sidings, the addition of 20 per cent. of ballast, the finishing of houses, the construction of one water-supply station, the completion of five water conducts, the erecting of superstructure of a bridge across Chulim River, the finishing the earthworks of Krasnoiarsk station, and the construction of repairing works there.

The Second Division of the Central Siberian Railroad, from Krasnoiarsk to Irkoutsk (675 miles), will be completed in the year 1898. The progress of work is illustrated by the following figures, relating to the end of 1896: Clearing 8,968 acres, grubbing 1,078 acres; temporary roads (along the located line), 620 miles; log roads in marshy lands, 27 miles; earthworks on main line, 15,000,000 cubic yards; on sidings, 1,232,000 cubic yards; finishing of slopes, 100,000 square yards; stone ripraps, 724 cubic yards; 15 cast-iron culverts are finished, and 47 stone culverts are in work (36,436 cubic yards of stone work is laid); 316 timber bridges are finished; of the great bridges four across the rivers Sitik, Benesovka, Rybna and Ouri are finished; the abutments of Doima bridge are finished, and the superstructure is in process of erection. Of the Ouda bridge two spans are erected. The foundations of the Yenissei bridge are in process of construction, and the wooden caissons are supplied for that purpose.

The track is laid on 150 miles of main line and 15 miles of sidings; 50 miles are ballasted. The telegraph is ready on the whole line.

Of the line buildings the following are under construction: 82 watchmen's houses, 33 large section houses, 57 small section houses, 48 wells, 104 road crossings, 23 passenger houses, 9 engine sheds (each for two engines), 7 water-tank buildings, 52 station houses for employees and the small repair works.

The cost of construction of the second division of the Central Siberian Railroad (675 miles), without rolling stock, is estimated at $23,400,000, or $34,666 per mile.

In the region of the Central Siberian Railroad, near the Station Kamishet, the first Siberian Portland cement works have been erected. They were built in 1895 and supply 2,500 barrels of cement each month for the Central Siberian Railroad, at the price of $6¼ per barrel.

Another great enterprise connected with the construction of the Siberian Railroad is the development of the Nicolalevsk Iron Works, on the Angara River, and in the vicinity of the Central Siberian Railroad (about 130 miles from the station Nijne Oudinsk). This plant has had three old blast furnaces, one Siemens-Martin steel furnace, one old steam engine of 600 H. P., and many obsolete rolling mills. Now this works are transfered to the new incorporated company of East Siberian Cast Iron, Iron Making and Mechanical Works, which has received from the government an order for supplying about 100,000 tons of rails and other railroad accessories.

The Nicolaicosk Works possess a sufficient stock of ore, and will use for fuel charcoal, which is to be prepared in the neighboring forests.

The company has reconstructed two old blast furnaces, and has begun to build two new blast furnaces, each with the production of 30 tons daily; it has reconstructed the old Siemens-Martin furnace, and will build a new one; it has ordered abroad a new rail rolling mill, which will be ready this spring, and then the manufacture of rails in Siberia for the Siberian Railroad will begin.

It is expected that the two already existing blast furnaces will yield 10,000 tons of cast iron, and that the order of the government will begin to be executed this year.

The greatest difficulty in operating this plant is the want of workmen, the country being very sparsely settled. The food for workmen must also be carried from Tekoutsk. It was expected that a party of 500 to 600 exiles and prisoners would be commissioned for the Nicolaicosk works, but only 200 men have been carried there; the balance will be forwarded this year.

The country crossed by the Central Siberian Railroad is not so level. The ruling gradient on its first 360 miles is 0.008 (or 0.8 per cent.), and on the remaining part of line 0.015 (1.5 per cent.), and the minimum radius of curved line is 1,050 feet.

(To be Continued.)

The Shops of the Q & C Company.

Some time ago the growing business of the Q & C Company, of Chicago, made it necessary for them to secure more shop space, and their manufacturing plant, which had been located in the city, was moved to Chicago Heights, a suburb some miles out on the Chicago & Eastern Illinois road. A recent visit to the new plant by a representative of this journal proved to be an interesting one.

The building is of brick, 210 feet long by 54 feet wide and two stories high, thus giving an available floor space of over 20,000 square feet, which is ample for present requirements. The office of the Superintendent, Mr. W. W. Holmes, is on the first floor, and the drawing office and pattern-room occupy a portion of the second floor. The building is well lighted throughout, and is heated by a hot-blast system put in by Messrs. Bailey & Sons, of Milwaukee.

There are many plants of this size in which, if we would judge from appearances, it is not considered worth while to strive for those economies in steam generation that are obtainable in comparatively large power plants, but this is not the spirit in which things are managed in these shops. The power is supplied by a good Porter-Allen engine and steam is generated by a boiler having a down-draft furnace, with which excellent results are obtained. The condensation from the heating system is returned to the boiler, and, in fact, nothing that can be saved is wasted. The coal is delivered in car-loads at the boiler room and with the down-draft furnace screenings at 90 cents per ton are burned successfully. The shop also has its own electric light plant.

The largest machines built in this shop are the company's cold metal sawing machines, which are made in various sizes and styles, ranging from small portable affairs up to power machines weighing over 16,000 pounds. We have in the past illustrated several of these saws and will soon publish engravings of others.

The company recently shipped to the Ironton Structural Steel Company, of Duluth, a saw capable of cutting off I-beams 30 and 40 inches deep, and the 16,000-pound machines mentioned above have gone to steel foundries, where they are used in cutting off gates from steel castings. The great power of the machines can be appreciated from the fact that one of them cut through a piece of solid crucible steel 15 inches in diameter in the almost incredibly short time of 28 minutes.

The company can boast of nearly 300,000 freight cars equipped with Q & C doors. Naturally the car door work forms a large portion of the total output of these shops, and up-to-date machinery is employed in the manufacture of such parts as need machine work.

An excellent change has recently been made in the pressed steel brakeshoe key made by the company. It was formally U-shaped in section, but for some inches in middle of its length it is now made with the section in the form of a hollow square. This is accomplished by giving additional width to the sheet steel blank at that point, and by a second flanging movement bending it down to form the fourth side of the hollow square. The advantage of this change is that where the key bears against the head and shoe it presents a bearing for its full width, whereas formerly it offered on side only the two edges of the plate from which the key was made.

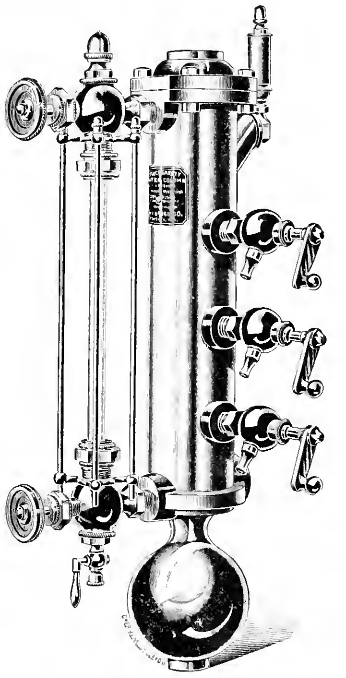
The McKee brake slack adjuster made by this company has been described in these columns. It has operated with success under very severe conditions, and the company is sparing no pains to make it reliable in every respect. They are now putting a case over the ratchet and screw mechanism, and also constructing the pawl so that it does not have to be raised when an inspector wants to let out the adjuster to put in new shoes. One could not ask for a more compact device than this adjuster now is. There is a good prospect of the adjuster being adopted as standard by a large and important road in the very near future.

The Reliance Safety Water Columns.

The safety water columns made by the Reliance Gauge Company, of Cleveland, O., are of two kinds, those which whistle only when the water in the boiler reaches the lower limits of safety, and those which whistle before the water either gets so low as to burn the boiler or so high as to be in danger of flooding the engine. Sections of both of these columns are shown herewith, together with an exterior view.

The columns are designed to form a check upon the operations of the fireman and to prevent carelessness on his part. If he is negligent and permits the water level to fluctuate up and down he is certainly not doing his work in a manner that will keep the coal bills down to a minimum. Furthermore, his inattention may at any time result in something more serious than waste of coal—there may be a burning of the boiler or an explosion due to low water, or a breaking down of the engine from the presence in the cylinders of water carried over from the boiler. The alarms on these safety columns are not provided for those in the boiler-room, but to give information to the superiors of the fireman as to the way in which the latter does his work. The presence of these alarms, however, and the knowledge that carelessness on his part will certainly be known by others, tends to make the fireman careful. Where he is not sufficiently self-respecting to keep the proper water level under such checks as these, there is abundant proof of his neglect and a chance to properly discipline him. In justice to the fireman it should be said, however, that ordinarily he is as pleased with the safety water column as is his employer.

From the engravings it will be seen that the column is provided with one or two floats according to whether it is to give an alarm

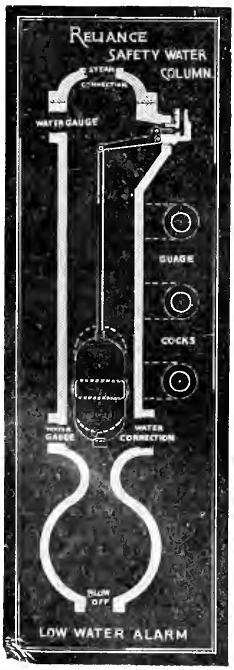


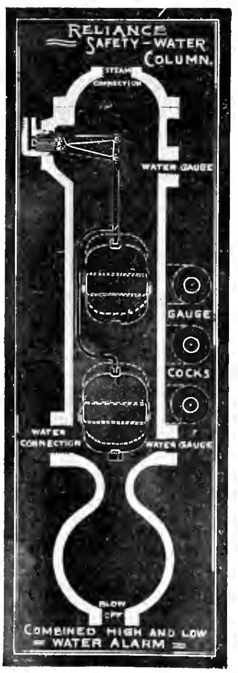
The Reliance Water Column.

for low water or for both low and high water. The floats are of superior quality, patented by the company, and are solderless. Their reliability can be inferred from the fact that of the thousands put in use in the last 10 years less than two per cent. have failed in any way. These floats do not move with every change of water level, and hence do not wear themselves out rubbing on the sides of the column.

One of the great enemies to reliability of any device about a boiler is sediment. These columns have sediment chambers at the bottom to which blow-offs are attached, and not only is the whistle protected from the presence of sediment, but likewise the gage-cocks and water glass. The whistle connection is the shortest possible.

An entire absence of objectionable features is claimed for these safety columns. They have no leaky floats, no mud-catching valves or mud chamber between the valves and the whistle, no adjustable "knockers" to become loose or to be adjusted in a way to render the appliance inoperative. The floats do not rise and fall with every movement of the water. There are no complicated parts to corrode or stick, and there is nothing to adjust or readjust.



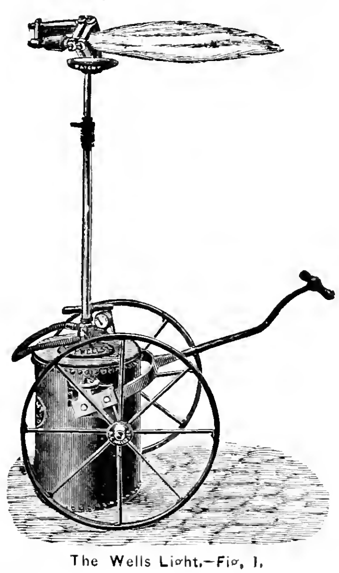


There are no fusible plugs to be rendered nonfusible by heat, or by becoming coated with scale or sediment. There are no expansion tubes, which fail chiefly on account of the interference of sediment and consequent failure of the water to run out of the tube and admit the steam necessary to expand it. Furthermore, the workmanship is of the very best.

From what we have already said it should be clear that these safety columns are not merely safeguards for the purpose of preventing boiler explosions; their purpose is to prolong the life of the boilers, reduce the cost of maintenance, lessen the waste of fuel and obviate stoppage, and to protect life and property, all of which is accomplished by causing the water to be carried steadily at the proper level. Boilers last longer and it costs less to keep them in repair if the water is carried steadily at the proper level. It is also easier to maintain steady steam pressure, and less fuel is wasted. Owing to the low cost of these appliances, the saving resulting from their use is an excellent return on the investment.

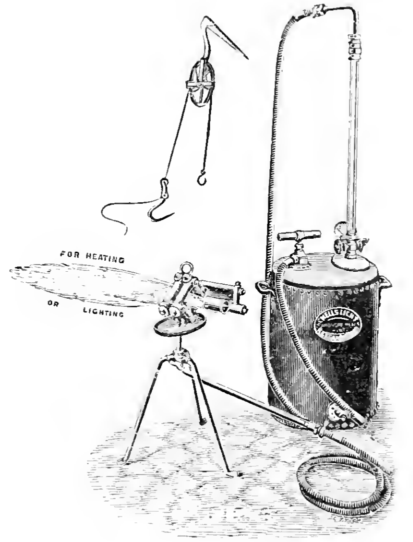
The Wells Light for Heating and Lighting Purposes.

TheWells light is doubtless familiar to many of our readers as an almost indispensable light for many kinds of regular and emergency work that must be carried on at night. Its value to contractors in almost every conceivable line of work is well known, and thousands of them are in use for tracklaying, bridge building, municipal work, general construction and repair work, and around shipyards, drydocks, wharves, quarries, blast furnaces, etc. It gives a powerful clear white light, free from smoke or spray, and one that cannot be affected by the weather. The device is self-contained and perfectly portable. It consists of a tank into which kerosene oil is pumped by means of a hand pump until it is about two-thirds full. The air in the tank is by this operation compressed to about 25 pounds' pressure. An upright pipe extending from the top of the tank carries at its upper end the burner. This is heated preliminary to starting the light by a small quantity of oil burned in the pan immediately under the burner, and when sufficiently heated the oil valve at the tank is opened slightly, and the oil as it passes through the burner is completely vaporized and burns with a perfect combustion outside of the burner. Once started the oil is vaporized before combustion by heat supplied by the burner itself. A few strokes of the pump every few hours is all that is necessary to renew the pressure, and oil or air can be pumped into the tank while the light is burning. Over 10,000 lamps have been sold in this county, a fact which attests to their excellence. On the Chicago Drainage Canal about 60 Wells lights were used, and on the present work on the Erie Canal about 30 are already employed. When desired these lights are provided with a detachable two-wheeled carriage by means of which one man can easily move them about. This is seen in Fig. 1, which shows a No. 3 light which is of 2,000 candle-power, has a flame 30 inches long, a tank 18 inches by 24 inches, and uses only one gallon of oil per hour. It will burn for 14 hours without recharging. The great size of the flame prevents the casting of sharp shadows such as produced by an electric light, and which are so annoying.



The Wells Light.—Fig. 1.

While our readers may be familiar with this light as used for lighting purposes, we doubt if they have as fully considered its merits as a device for heating, particularly where the heating is to be confined to a small area. In railroad shops the use of the Wells burner for heating tires when setting or removing them is common, but there appears to be no good reason why these burners should not also be used for many repair jobs in machine shops, roundhouses, etc.



The Wells Light.—Fig. 2.

Locomotive frames that have been bent at points that would permit of straightening without removal can be heated with these burners, and even when a frame is removed for straightening, the advantage of heating it locally only is obtained by the use of these burners. In boiler work also it is handy.

Water-works companies and contractors have recently found a use for it in repairing water mains.

To remove sections of pipe it is necessary to melt the lead in the joint, and this has heretofore been done by crude means that has consumed much time and invariably resulted in the loss of the lead. Now Wells burners are used and a receptacle placed under the joint to catch the lead. The intense heat concentrated on the lead melts it quickly, and a great saving of time and lead results. So successful has been this application of the device that many orders are being received for outfits adapted to this work.

Around shipyards and drydocks the Wells light is frequently used for heating purposes, particularly in repair work. Something over a year ago a Clyde Line steamer grounded in New York Bay and bent several of her plates. She was taken to a dock, a Wells outfit for heating was purchased, and with it the plates were heated and straightened, the ship going out again the next day.

The Wells Light Manufacturing Company makes the arrangement for heating (which can also be used for lighting) shown in Fig. 2. The burner can be swung up to a wooden pole or beam, or lowered below the level of the lamp, and is thus rendered practically independent of the tank. For use in drydocks or up and down the sides of a ship during building, it is invaluable.

The company is prepared to adapt the light to any special heating purpose and to provide the mechanism that may be needed in such cases in addition to the tank, burner, etc. The Wells light is made by the Wells Light Manufacturing Company, Edward Robinson, sole proprietor, 44 and 46 Washington street, New York City.

The Geipel Steam Trap.

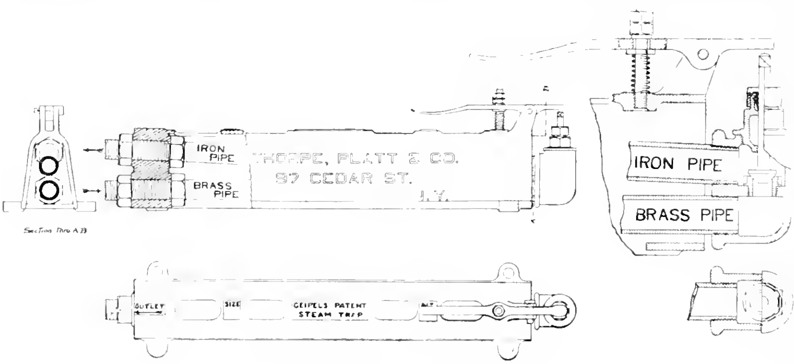
We illustrate herewith a new steam trap placed on the market by the firm of Thorpe, Platt & Company, 97 Cedar Street, New York City, and which possesses many merits. It has no floats, no faced joints, no internal working parts of any kind, is compact and attachable in almost any part of a boiler or engine-room. Fig. 1 is an outside view of the trap, while Fig. 2 is a line drawing showing its construction. It consists of a cast-iron casing into one end of which is secured an iron and a brass pipe. The other ends of these pipes are screwed into a valve body as shown, which is not attached to the casing, but is supported by the pipes only. The brass pipe is the inlet pipe and the iron pipe the outlet. If both pipes are at the same temperature the valve body is at the height shown in Fig. 2 and water seeking an escape would raise the valve and pass through the iron pipe. But if steam enters the brass pipe, it immediately expands it and by so doing raises the valve body, the spindle of the valve being forced against the adjustable lever shown and thus firmly held to its seat. The escape of steam is thus shut off and with remarkable promptness—so quickly in fact that the action of the trap cannot be timed by a stop watch.

The Geipel Steam Trap.—Fig. 1.

This rapidity of action can doubtless be attributed in part to the fact that steam begins to close the trap as soon as it enters the brass pipe and while it yet has to traverse the length of the latter.

This trap will discharge a continuous stream of water the full bore of the pipe connections. The valve is easily examined and replaced, only two minutes being required for the operation; it is accomplished by removing the cap of the valve body. The valve seat is renewable. The valve can be opened by hand to blow through the trap, and can be left open if desired. The trap will work in any position. The instructions for connecting and working the trap are as follows:

Connect the lower or brass pipe, which is the inlet, with the steam pipe or vessel to be drained by at least 3 feet of pipe, in which a valve or cock should be inserted. The top or iron pipe is the outlet, and should be connected with the drain, or it may discharge into a tank at any height within the head equivalent to the pressure of the steam. In the latter case a non-return valve is preferable on the outlet to prevent the water returning into the steam pipe when cold.



The Geipel Steam Trap.—Fig. 2.

When the trap discharges into a sealed drain it is an advantage to have a three-way cock on the outlet, one branch being arranged to deliver to the atmosphere in order that the working of the trap may be inspected. To blow through press down the lever. To adjust the trap, screw down the nut on the lever until steam blows through, then slack back until steam is shut off and lock the nut. The trap will then only discharge water. When fixing to new steam pipes it is well to blow through the connection to the trap before the latter is fixed, in order to clear away any dirt in the pipes. If any steam should blow through, the valve should be examined, which may be done by unscrewing the cover.

The trap is specially adapted for marine and electric light work, and for steam pressures from 135 to 300 pounds per square inch. To marine engineers it presents several special advantages in addition to those already enumerated. Its working can be seen from the outside and it is not necessary to take off covers or break joints; it is very light; its construction is such that it may be conveniently fixed on the engine columns or bulkheads, vertically or otherwise, and will drain the main steam pipe, the valve casings, the steam jackets or branch pipes to auxiliary engines, keeping these important parts clear of water without loss of dry steam. In so doing there is not only a distinct economy in steam, but also in packing, which is found to last longer when this steam trap is used. An additional advantage is that less water is lost through the glands, "the fresh water make up" thus being less. This has been found in practice an important economy. This trap has met with most extraordinary success in Europe, and is used by the British Admiralty for high pressure steam and also in public buildings where heating with exhaust steam is employed.

CONSTRUCTION AND MAINTENANCE OF RAILWAY CAR EQUIPMENT.—XI.

BY OSCAR ANTZ.

(Concluded from page 64.)

BOX CARS.

Box cars are adapted for carrying almost all kinds of material which is not too large to pass through the doors and which does not have to be protected against changes of temperature.

A box car consists of a framed house or box placed on the floor-frame which has been shown, which is provided with doors on the sides and sometimes on the ends and is covered by a tight roof. The usual dimensions of box cars are from 34 to 36 feet long over end sills, 8 feet 6 inches to 9 feet wide over side sills and about 7 feet high in the clear inside. The framing consists of a series of posts and braces between the roof plates and floor frame, tied together by means of rods, and while there are many different styles of framing in use, there is a tendency toward one style which will be described in a general way.

At the four corners of the car are placed corner-posts; at each side of the door openings are doorposts, and over each end of the body bolsters are body-posts. The space between the latter posts and the doorposts is divided into two or three parts by one or two other body-posts. From the foot of each body-post, over the bolster, braces extend upward, one to the corner made by the corner-post and side plate, and one to the corner of the adjacent body-post and the plate. From the bottom of the latter post another brace extends to the next body-post and so on, there being a brace between every two posts. The corner and door posts are usually framed into the side sills and plate by mortices and tenons, the other body posts and braces are set into castings which are framed into the timbers by means of dowels. The plate and sills are tied together by means of rods, usually one to each post, excepting, perhaps, the posts over the bolster, and diagonal brace rods are run down from the top of the latter post to the bottom of the corner-post and adjacent body-post, and sometimes another brace rod is placed in the next adjacent panel. The nuts on top of these rods are let into the top of the plate, and washers are put under the nuts of all the rods, those on the brace rods being beveled to the proper angle. The brace rods are omitted by some builders, who rely solely on the tie-rods for holding up the framing, but the good results obtained where they are used and the small additional cost of putting them in would certainly seem to warrant their use in all cases.

The ends of cars are usually framed of two posts, spaced equally between the corner-posts, and two braces running from the tops of these posts to the bottoms of the corner-posts. Sometimes four vertical posts without any braces are substituted. A vertical tie-rod from end plate to end sill is placed near each post. The corners of the car body are fastened together by short tie-rods, and further by corner irons, inside as well as outside, bolts passing through both angles.

The side and end plates form the upper corners of the car body, and into them are framed the side and end framing and the framing of the roof. The end-plate is straight on the bottom, the upper side being beveled both ways to the shape of the roof; it is framed into the side plated by mortice and tenon, and secured by a horizontal tie-rod. About midway between the plate and sill are placed the side and end girths, which are cut out for each post and brace, and are lipped over door and corner posts.

The outside of the car is covered with matched sheathing, $\frac{7}{8}$-

inch thick, usually about 5 inches wide, beaded or grooved at the joint between the separate boards, with a similar bead or groove through the center of the board. The sheathing runs from the top of plate to the bottom of end sill, and is nailed to these timbers and to each frame, brace and girth which it crosses. The door-posts are rabbeted out for the sheathing, but the corner-posts are usually enclosed by it. The inside of the car is generally sheathed horizontally, as far as the girth, the upper part of the framing being exposed, though sometimes the entire inside is sheathed. The inside sheathing should not reach all the way to the floor, and a triangular strip of wood should be placed in the corner between outside sheathing and the floor, to facilitate the removal of grain or other fine material which is apt to work its way behind the inside sheathing when loaded in bulk form. The top end of the outside sheathing is covered by the frieze boards, a narrow piece of wood nailed to the plate and to this is fastened the eave moulding.

ROOFS.

There are quite a number of different kinds of roofs in use on box cars, but the framing of most of them is about the same, and consists of a number of carlines, extending from side to side of the car, and mortised into the side-plates. The top is beveled to the slope of the roof while the bottom is straight. The carlines are tied to the plate by means of tie rods extending across the car through both plates, though sometimes they run only from the purlines to the plates. The ridgepole is mortised into the carlines and end plates at the center on top side, and the purlines are spaced between the ridgepole and side plates, usually one or two on each side of the car.

One of the earliest roofs in use, and one which is sometimes still used on large cars, is the so-called double board roof, which is made of two layers of boards, all of one width, the two layers breaking joints with one another; grooves are usually cut into the boards to conduct any water which gets on the roof or between the two layers, down to the eaves. This roof gives considerable trouble on account of the nails which fasten it breaking off, whereby water gets into the boards and causes decay.

Quite a common roof is the tin roof, consisting of sheets of tin soldered together and fastened upon a single layer of roof boards, which usually run lengthwise of the car. This roof is liable to break at the joints of the sheets, and unless the tin is of the very best quality it will rust very soon from the effects of the gases from the locomotive. Other roofs are made of canvas, tarred paper or other material, placed over a single layer of boards or between two layers of boards, and all of these have their good and bad points.

One of the most extensively used roofs, which keeps in good condition for a long time, but is somewhat more costly to put on than some of the others, consists of sheets of galvanized iron, rolled in the form of a channel, which extend across the car, their edges being held in grooves cut into sub-carlines fastened to the purlines. These sub-carlines are covered with caps of galvanized iron screwed fast to them, which lap over and into the channeled plates, conducting any water which gets on them through these to the eaves. Over this iron roof is laid a wooden one, which protects the one under it from damage by trainmen walking on it. When well put together with good-sized screws this roof ought to last as long as the car itself.

On top of the roof, usually over the center, is placed a horizontal beard, or several boards, making up a width of about 24 inches, which serves the trainmen to pass from one end of the car to the other. This board should project about 6 inches beyond the end of the car body, bringing the adjacent ends of the running boards of two cars close enough together to enable trainmen to step from one to the othet. These running boards are usually secured to saddles cut out on their lower edge to the shape of the roof and securely fastened to it. At the ends of the car short pieces of running boards are sometimes located between the main running board and the sides of the car, to enable the trainmen to reach the ladders to descend to the ground without having to step on the roof proper. These ladders are usually made of iron rungs fastened either to wooden sides or direct to the car; in the latter case their ends are offset so as to bring them away from the side of the car sufficiently to give a foothold. At the top of the ladder, on the roof, is placed a short piece of hand-railing or guard, to assist trainmen to mount the roof from the ladder. Two ladders are usually provided, placed at diagonally opposite corners, and they are either put on the end or the side of the car, close to the corner. On both sides of the car, at each end, are placed steps made of flat iron in U-shape; extending below the side sill, to assist trainmen to mount the ladders or pass over the platforms of the cars. Handholds or grabirons are provided at convenient places to assist trainmen in passing along or over the cars, or when coupling or uncoupling while cars are in motion.

The brakeshaft usually extends over the roof of the car, on which the brakeman stands while using it, although sometimes a step is arranged for this purpose on the end of the car slightly below the roof.

DOORS.

While the number of different kinds of box-car doors is very large, it can be said that as yet no really satisfactory one has been devised. Some of the important points which should be found in a good door are simplicity and ease of operation, security against water, dust and cinders, and against theft, and security of fastening.

Security against water and other detrimental substances is obtained to some degree by having the door fit in a beveled opening, making it flush with the outside sheathing when closed. This style of door is, however, difficult to open when it is fitted close enough to obtain the security desired.

A very simple door can hardly be obtained if the other points mentioned are to be considered, but is approached somewhat closer in some of the doors which close by lapping over the door-posts.

Doors should be hung from a track fastened to the side of the car above the door, and for ease of operation the hangers should be provided with sheave wheels. To exclude water, cinders, etc., there should be a lapped joint at each of the four sides of the door. Theft of goods in a car is often accomplished by prying the door away from the side of the car sufficiently to remove them, and this is prevented by providing brackets on the side sill of the car which will not allow the door to be pried away from the car, an improved form of this bracket being arranged so that it cannot be removed while the door is closed. One of the most important points to be considered in car doors is to have them secure against being displaced, even if certain parts should become broken, so that the door will not swing away from the car and possibly damage cars on the adjacent track. This is accomplished in a recently introduced door in which plates of iron on the door when closed lap behind other plates fastened to the car.

The door proper is sometimes made as a regular framed structure, with panels set in rabbeted posts and rails, but in most cases the doors are simply made of sheathing nailed to a plain frame of pieces of boards, lapping or butting at the corners, and sometimes provided with two braces to keep them square. The doors are provided with an attachment for holding them closed, consisting of a hasp and staple and some kind of a pin through which the wire seal is passed after the car is loaded. A handle is provided for moving the door and a stop is placed on the side of the car to prevent the door from being moved off of its supports.

Box cars are sometimes provided with doors in the ends, through which long material is loaded which cannot be placed in the car through the side doors. These end doors are usually of the same pattern as those on the sides, but always considerably smaller.

It is often desirable to expose certain ladings, such as fruit and vegetables, to a change of air, and many cars, especially in the warmer parts of the country, are provided for this purpose with screen doors in addition to the solid ones, either of which can be placed before the door, opening at will. The screen doors are usually made of an ordinary frame covered with some kind of metal screen, or iron bars are inserted in the frame vertically, leaving a small space between them.

The end doors, with which such cars are usually provided, are also fitted with screen doors, and additional ventilators are often provided through the sheathing of the car.

Grain of different kinds is usually carried in box cars in bulk, and to confine it in the car it is necessary to provide some way of closing up the door pening from the inside, as the regular outside-hung door would not be tight with the pressure against it from the inside. Boards nailed to the inside of the doorposts, to the height of the lading would be sufficient, and are sometimes used, but generally the cars are provided with permanent grain doors, which are attached to the car and remain with it, although they are not considered as a necessary part of the car. Grain doors are usually made of matched boards nailed to a frame, and are long enough to lap over both doorposts, the height being about 3 feet. When in use the doors are held against the posts, by means of sockets or hooks, and when not in use they are stored out of the way, either on the side of the car or hung from the roof, permanent attachments in the shape of rods, levers or chains being provided to prevent the door from being lost.

FURNITURE CARS.

Box cars of the ordinary sizes cannot be loaded to their full carrying capacity with certain kinds of material which takes up considerable space for its weight, such as furniture, carriages, hay, etc., and this has led to the building of box cars of the usual capacity of 60,000 pounds, but of much larger dimensions than usual, which cars are variously called furniture, carriage, buggy or hay cars. The extreme limits to which these large cars should be built is a question which at present is causing considerable discussion, the traffic departments calling for even larger cars than those already built, while for the sake of strength and weight the present sizes should not be exceeded. The cross-section of the cars is limited by the clearance of bridges and the other structures along the line of the roads, and many cars in existance to-day will not pass over certain roads. The length of most of the existing furniture cars is about 40 feet, although some 50 feet long and a

few 60 feet long have been built; the width runs from 9 to 10 feet over side sills, and the height from 8 to 9 feet inside in the clear.

These cars do not differ to any great extent in their construction from ordinary box cars, the framing being very much alike, additional posts and braces being put in on account of the greater length of the cars. To get the increased height inside without having the height over all beyond the limits for clearance the floor has to be placed nearer the rail, which necessitates a change in the draft gear, this being placed usually between the center sills, no regular draft timbers being used, and the end sill is made considerably deeper to allow the drawbar to pass through it. The door opening is also made considerably larger, and grain doors are usually omitted.

On account of the low floor, the trucks have to be lowered correspondingly, which is sometimes done by changing the offset of the arch bars from that of the regular cars, though in some cases specially designed trucks are required.

Even with the large side doors, it is sometimes not possible to get large carriages through them into the car, and for this purpose large folding doors are provided in one or both ends of some cars made in two parts, hinged at the sills and opening outward.

HEATER AND REFRIGERATOR CARS.

As has been stated, ordinary box cars do not protect the lading against changes in temperature, and perishable material has to be transported in cars built for this special purpose.

For protection against cold, which is necessary during winter weather in transporting fruit and vegetables, so-called heater cars are provided. These consist of box cars of which the sides are made double, and often provided with air spaces, felt or other non-conducting substances between the inner and outer sheathing. On top of the car is a funnel, through which air is blown by the motion of the train into a pipe which conducts it to a stove in a box suspended from the bottom of the car, where it is heated, and it then passes to the interior of the car. Kerosene is used in the stove as fuel, a tank being provided from which the oil flows to the stove automatically as needed. The heat is regulated automatically by means of the expansion and contraction of metal rods, and while the temperature maintained is not very high, it is sufficient to prevent the lading from being frozen.

Fresh meats and other commodities which must be kept at a low temperature, are transported in refrigerator cars. These also consist of box cars whose walls are made of two or three thicknesses of boards, separated by air spaces or non-conducting material, and provided with tanks for holding the refrigerating medium, which is usually ice or ice and salt.

While the general principle of these cars is about the same, there are quite a number of different systems of refrigeration which differ in their details and each of them possesses, no doubt, some merit of its own. The tanks are usually arranged in such a manner, in connection with partitions in the car, that a current of air is created, which passes over the ice and then into the body of the car. In some systems a current is created by the motion of the train. The tanks are made of galvanized iron and are provided with drip-pipes, which are sealed against air entering them from the outside by a small pan filled with water, into which the lower end of the drip-pipe enters.

The doors of refrigerator cars are made as thick as the sides of the car and are insulated in the same way; they are usually made to fold, being hung on hinges, and the edges are made on a level with several offsets, the door opening being arranged in a corresponding manner, and canvas is often used to make a tight joint. Doors are provided in the roof for filling the tanks with ice.

Material requiring the use of refrigerator cars is transported usually only in one direction, toward the coast, and when box cars are in demand for lading destined in the opposite direction, some roads make it a practice to remove the ice, by means of steam, from the cars, after the perishable stuff has been unloaded, and after thoroughly drying the car, it is used in regular service going to its starting point.

STOCK CARS.

In the transportation of live stock, provision must be made to admit light and air to the cars and as almost all stock, with the exception, perhaps, of certain kinds of horses, will stand a moderate amount of cold without suffering, little if any protection is given against the weather.

Stock cars can be described as box cars without the solid inside and outside sheathing, this being replaced by slats of wood with open spaces between them. The framing of stock car bodies varies perhaps more than that of any other kind of car and there does not seem to be any particular style which might be selected as being most in favor. Posts are used, of course, in the framing and there are quite a number of ways of fastening these to the floor frame. Some are set in stake pockets on the side sill, some are merely bolted to it; others are set on the side sill, being mortised into it; others again are set into cast pockets, which are framed into the top of the side sill. Braces are used on some cars, while some builders put in a large number of posts and depend on the slats for bracing of the body, or put in short braces between the posts, extending up only two or three feet, which is necessary with some kinds of feeding and watering attachments. Probably one of the best systems of framing is similar to that of the box car which has been described, consisting of corner and door posts, body-posts over bolster and one or two more between this and the door post; braces running from the bottom of the bolster body-post to each adjacent post and other braces from the bottom of the other body-posts to the top of the next one toward the center of the car. The ends are framed with posts and braces similar to those on box cars and brace and tie rods are used in the same manner as in those cars.

The bottom of the posts and braces are set in pocket casting on top of the side sill, high enough to project above the floor; the bottoms of the pockets have holes cast in them to the outer edge to carry off any liquid matters which might find their way from the car into the pockets.

Horizontal slats are nailed to the posts with a space of 2 or 2½ inches between them, the slats being generally about 5 to 6 inches wide, although often the lower one or two boards are made wider. Both sides and ends of the car usually have these slats, though recently the ends of many cars have been sheathed up solid to afford some protection against the weather. The top part of the sides is sometimes made solid far enough down to allow for the name and number of the car, or if this is not done, the lettering is placed on boards which are fastened to the outside of the posts.

The doors of stock cars are usually placed in the center of the sides, though sometimes they are found near the ends; they are made of an open frame, which is provided with vertical or horizontal slats of iron rods, and are hung from a rail at the top of the door opening, the lower part being guided by a bar of iron fastened to the door and turned up on the inside of the side-sill, or secured when the door is closed by some sort of a hasp and staple fastening.

End doors are often put on stock cars to be used for loading long material, such as lumber, rail, etc., for which these cars are sometimes utilized, especially on the return trip after having been used for a load of stock. Across the doorways on the inside of the car, a bar is often placed to prevent the stock from pressing against the door and loosening it from its fastenings.

To utilize space in transporting small animals, such as hogs and sheep, an additional floor is placed in the car, dividing the vertical space in two, this floor being often put in temporarily, though some cars are built with a permanent double deck. In the latter case, each deck has its own independent doors, the lower rail of the top one also serving as top rail of the bottom door.

The roofs of stock cars need not necessarily be very tight and as a rule only single or double layers of boards are used. The attachments for the safety of trainmen are the same as those decribed for box cars.

The feeding and watering of stock in transit is generally done by driving the animals into pens at certain stations for that purpose. Many contrivances have, however, been introduced for feeding and watering without unloading them. Hayracks are placed in some cars along the top of the sides which are made of a skeleton frame hinged to the side of the car at the bottom and held in place when open by chains; when not in use the frames are fastened up to the side of the car. On other cars boxes are placed on the roof along the sides for the same purpose of holding hay, the bottom of the boxes being made of slats or bars.

Troughs for watering or feeding are placed on the sides of the car, two or three feet up, or on or near the floor, of double-deck cars, some of which can be swung out of the way when not in use by means of rods and levers leading to the side or top of the car. Pipes are often provided to which a hose can be attached for supplying water, or the water is brought through them from a tank in the roof of the car.

For transporting blooded horses and cattle a better class of cars is usually used, which are sheathed inside and out for at least part of the way up, and are often provided with windows whereby the car can be closed entirely. Stationary or movable stalls, feeding and watering appliances and other conveniences are also provided.

In the transportation of live poultry somewhat larger cars are used, which are fitted up with boxes or crates in tiers, and the sides of which are closed in by wire netting; some of the floors are movable, so as to allow for transporting small and large-sized fowl, and troughs for feeding and watering are also provided.

The capacity of stock cars is seldom as high as 60,000 pounds, as a car of the usual size could not be loaded with that weight of cattle, and the trucks are therefore generally built lighter; and as an easy motion is very desirable with the class of freight carried, the trucks are generally built with swinging bolsters and often provided with elliptic springs.

TANK CARS.

For the transportation of liquids in bulk, such as oils of all kinds, acids, molasses, syrups, etc., flat cars are used on which is placed a cylindrical iron tank, lying horizontally; provided at its center with a dome, in the top of which is a manhole through

which the tank is filled; a connection and valve at the bottom being arranged for emptying it. The heads of the tank are dished outward. The tank rests on longitudinal subsills and is fastened to the cars by means of iron straps passing over the tank with bolt ends passing through the floor frame. Handrails of iron pipe are provided along the sides of the car for the protection of trainmen.

Compound Compressed-Air Locomotives.

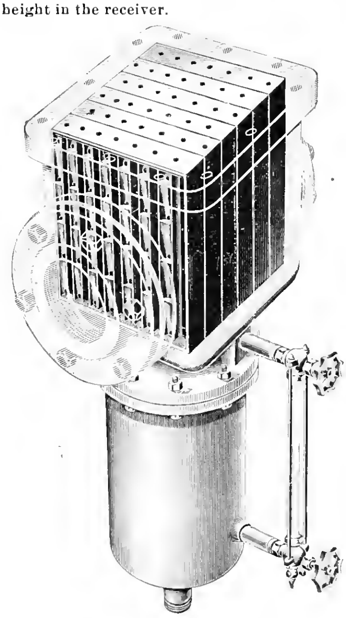
The Baldwin Locomotive Works are building a compound compressed air locomotive to be used at the Alaska Colliery of the Philadelphia & Reading Coal and Iron Company. The air will be compressed by a three-stage Norwalk compressor. A "standard line" pipe 2,680 feet long and guaranteed to stand a pressure of 1,000 pounds per square inch will extend through the mine and serve as a reservoir for the storage tanks on the locomotive, and provision will be made so that these may be charged from the long pipe in two or more places in the mine. The locomotive cylinders are 5 and 8 inches by 12 inches, and the valves, ports and connections are of the same general type as are in use on the Vauclain compound locomotives. The driving wheels will be 24 inches in diameter, wheel base 4 feet 6 inches, and the track gage 3 feet 8 inches. The air will be stored at a pressure of 600 pounds, in three reservoirs having a total capacity of 170 cubic feet. The working pressure of the air in the high-pressure cylinder will be 200 pounds, and the cut-off will take place at one-half stroke. The height will be 5 feet 3 inches, width 6 feet, length over all 16 feet, and the distance between drivers 4 feet 6 inches. No reheater of any kind will be used.—Railroad Gazette.

Bundy Steam and Oil Separator.

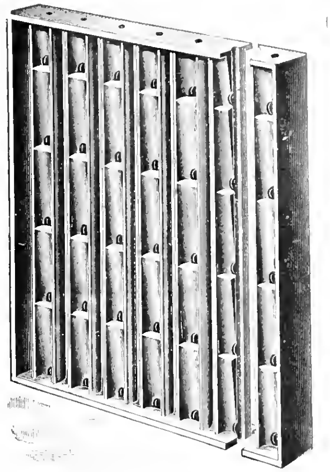
Different natural laws have been employed by separator manufacturers to remove water from live steam and oil from exhaust steam. Both gravity and centrifugal motion have been used, and now another force has been employed, that of capillary attraction, used in the Bundy separator.

A series of baffle plates are placed directly across the steam passageway and at right angles to it. Each baffle has a number of upright tubes supplied with openings leading to a main duct or capillary which terminates in the receiver below. The upright tubes of one baffle plate are set staggered to those back of it so as to subject all the steam in passing through to a thorough separation. There are ample sized openings left between for the steam to pass through without diminishing the pressure.

Below the separator proper, and a part of it, is the receiver, which may be fitted with a special device for the automatic removal of the water or oil as soon as it has accumulated above a certain height in the receiver.



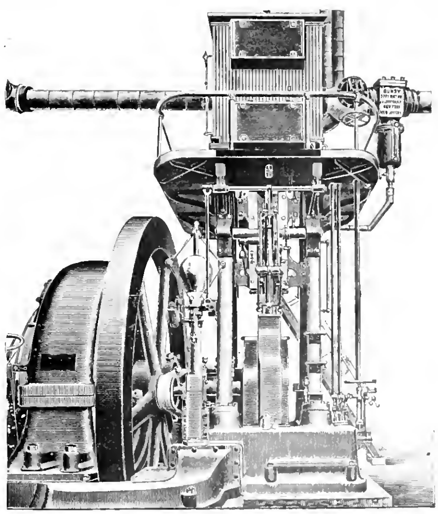
Bundy Steam and Oil Separator.



Baffle Plate of Bundy Separator.

The manufacturers in marketing this separator call attention to the natural well-known affinity water and oil have for following capillary pores, and claim that it is impossible for either to pass through or to be picked up again by the steam after it has once been separated. The water and oil follow the capillary passageways to the receiver and do not lose contact with the iron until delivered to the receiver from which there is no return circulation.

A late example of the application of the Bundy separator is here illustrated in the power-house of the New York and Brooklyn Bridge, where two ten (10) inch separators are in use. They were sold under a guarantee to deliver $99\frac{58}{100}$ pure dry steam, and upon completion fulfilled the guarantee by passing the test imposed.



Ten-Inch Bundy Separator In Brooklyn Bridge Power-House.

The Bundy separators are made at the works of the A. A. Griffing Iron Company, Jersey City, N. J., with distributing offices in New York, Boston, Philadelphia and Chicago, and the specimen of condensation taken from exhaust steam after passing the Bundy oil separator shows absolutely no trace of oil.

Steel Portland Cement.

The Illinois Steel Company has for some time past been making at its North Chicago works a cement from blast-furnace slag, to which it has given the name "Steel Portland Cement." In a pamphlet which it has just issued, many testimonials to its merits are given by prominent architects, contractors and engineers. In an introductory some interesting facts are given regarding the material, from which we take the following:

Cement has been manufactured in Europe, mainly out of blast furnace slag, for many years, and there are repeated cases of important work in which it has stood as well as old-established brands of ordinary Portland cements placed alongside it. The great sea-wall on the Yorkshire coast, England, made entirely of this class of material more than ten years ago, is to-day in the best condition, and the same can be said of the foundations of the German Parliament buildings at Berlin, and of the great water-works conduit at St. Louis in our own country. This last undertaking alone necessitated over 500,000 barrels of cement to complete it.

Moreover, there is a striking similarity, both chemical and physical, between blast furnace slag, the material from which Steel Portland Cement is chiefly made, and Puzzolanic lavas, the basis of the famous old Roman cements. These have not deteriorated during an exposure of 20 centuries, the walls of the Coliseum at Rome and of other celebrated buildings being to-day in first-class condition. On account of this similarity, and owing to the fact, shown by the tests, that Steel Portland Cement continually increases in strength with age, the Illinois Steel Company believes, with good reason, that its new product will, like the celebrated Roman cements, successfully stand the test of time.

The serious opposition which slag cement has hitherto encountered has been mainly due to two causes: First, its irregularity, and second, its slowness in setting, requiring from five to 24 hours to harden. The first difficulty arises chiefly from the fact that the slags of Europe are of themselves not at all uniform in composition. Furthermore, the slag-producers of Europe are seldom the cement manufacturers, and as the former consider the product of the latter merely of secondary importance, there is little effort made to produce a uniform slag, and consequently a uniform cement; the result is an article not to be depended upon, though at times of striking excellence.

With the Illinois Steel Company, however, the case is very different. Its slag is made from the purest and most regular ores in the world, and these ores are bought with special view to their qualifications for making regular slag of the composition best suited to the manufacture of cement. Moreover, before the material is used, each lot is submitted to the most careful chemical analysis, and all material not of the correct composition is absolutely discarded.

The second difficulty, that of slow setting, is overcome by patented as well as secret improvements in the process, making it possible to control the time of hardening of the finished product so that it will fulfill the requirements of almost any class of work. Steel Portland Cement has been used successfully in bridge construction; in the erection of large and important office buildings; for heavy concrete-work of all kinds, including foundations for engines, etc.; for fire-proofing of buildings; for lining mud drums of boilers (a most severe test); for laying brick and stone; in short, for nearly all purposes requiring a high-grade Portland cement. On account of its high tensile and compressive strength—due to the fineness to which it is ground—it is particularly well adapted for these classes of work, but also on account of its fineness it has comparatively low abrasive strength and therefore is not so well suited for granitoid work as are some other brands in the market.

Appreciating the fact that its reputation as a steel-producer must not be jeopardized by a failure of one of its other products and realizing its responsibility to the building trade in general in vouching for a new cement, the manufacturers submitted this material for several years to practical as well as theoretical tests before placing it upon the market. That Steel Portland Cement is to-day giving the very best satisfaction is evidenced by the high character of the testimonials received, and that the Illinois Steel Company has the greatest faith in the future of the product is shown conclusively by the fact that the capacity of the plant is being increased as rapidly as possible.

Among the claims made for this cement are the following: It is uniform in color and quality; it is ground to a greater degree of fineness than any other cement in the market; it shows great and constantly increasing strength when tested with sand or as used in practice; it contains absolutely no free lime, which is the common cause of cracking in Portland cements; it stands successfully the boiling test, a test for stability; it does not stain; the finished product presents a light-colored and smooth surface of uniform appearance; on account of the fineness to which it is ground it works easily under the trowel, consequently the masons all like it; it is submitted to careful chemical and physical tests before shipment; it constantly increases in strength with age, thereby insuring stability; it is sold at a price exceedingly low, considering its value; the manufacturers use it themselves in work of the greatest importance to the exclusion of all other high-grade cements.

The Croton Aqueduct Commission of the State of New York made a test of the cement in August, 1896, and the following table is a summary of the results:

Date when mixed.	Proportion by volume.		Per cent. of water to weight of cement.	Final setting time.		Temp. water used when mixing.	Temp. of room.	* Tensile strength in pounds per square inch.						
	Cement.	Sand.		Hours.	Minutes	Deg., Fahr.	Deg., Fahr.	24 hours.	7 days.	22 days.	3 months.	6 months.	9 months.	1 year.
1895. July 31	1	0	28	2	26	56	62	149.6	270.6	363	436	404.4	511.8	575 8
July 31..	1	2	40	1	2	54	56	......	155.4	6.3.2	668.8	713 8	870	874.2

*All figures averages of ten (10) briquettes.

EQUIPMENT AND MANUFACTURING NOTES.

The Rio Grande Western has placed an order with the Ohio Falls Car Company for 200 cars.

The Mather Stock Car Company has contracted with the Ohio Falls Car Company for 50 live stock cars.

The Brooks Locomotive Works has shipped two 19 by 26 mogul engines to the Buffalo, St. Mary's & Southern.

The Wilmingtsn & Northern has placed an order with the Harlan & Hollingsworth Company for 200 gondola cars.

The Pullman Company is completing 12 sleeping cars for the Pennsylvania lines which are said to excel any yet built.

The Imperial Chinese Railway Administration is in the market for 10 passenger and 16 freight cars for the Sung-Wu Railway.

The Metropolitan Elevated Railroad of Chicago has placed an order with the Pullman Palace Car Company for 25 new trailer cars.

It is reported that the Mt. Vernon Car Manufacturing Company has received an order from the Louisville, Evansville & St. Louis for 100 coal cars.

Mr. C. J. Smith, receiver and general manager of the Oregon Improvement Company, has recommended the purchase of two new steamers, to cost $400,000.

The Schenectady Locomotive Works has received an order for five 20-inch by 26-inch 10-wheel passenger locomotives for the Southern Pacific Company.

The United States Air Refrigerating & Power Company, of New York, has applied for a franchise to lay pipes in the streets and sell compressed air in Newark, N. J.

On April 16 the Westinghouse Air-Brake Company passed the half-million mark in its brake freight shipments, having sold 503,519 sets of its automatic air-brakes for freight cars.

Bement, Miles & Company, through their Western representative, Mr. C. E. Billin, have sold to the Haskell & Barker Car Company, of Michigan City, Ind., a heavy axle lathe and a hydraulic wheel press.

The Pittsburgh, Bessemer & Lake Erie Railroad Company has placed orders for nine mogul locomotives of 167,000 pounds each. The Brooks, Pittsburgh and Baldwin Locomotive Works will each build three.

The through coaches of the Baltimore & Ohio Southwestern, which are used between the West and Baltimore & Ohio points, are to be painted royal blue, the new standard color of the Baltimore & Ohio.

The attachment for $12,000 placed upon the Rhode Island Locomotive Works, in November, by the Midvale Steel Company, has been discharged. It is reported that the works will resume operations in the near future.

The Pennsylvania Company is building at its Fort Wayne shops 200 gondola cars to fill vacant numbe rs in the equipment. The cars are to be equipped with Janney couplers, Westinghouse brakes and National brakebeams.

The Acme Journal Bearing Company, of Chicago, has recently been incorporated, with F. W. Thayer, President, and William Hamilton, Secretary and Treasurer. Its office and foundry is at 7 and 9 South Jefferson street.

Norcross Brothers, who secured the contract for excavation and foundations for the South Union Station, Boston, were on April 9th awarded a contract for the erection of the superstructure. The amount of the contract is almost $2,000,000.

A leading export firm placed a contract last month with the Brooks Locomotive Works for four locomotives for a private Japanese railroad company. The locomotives will weigh about 90,000 pounds each, and will have side tanks.

The Lake Shore & Michigan Southern is building five baggage cars at its Cleveland shop. The road has recently changed its standard passenger coach color from yellow to the Wagner standard. The striping and style of letters are also changed.

The Southwark Foundry and Machine Company, of Philadelphia, has secured an order from Russia for four large blast furnace blowing engines. The engines are to be of the vertical compound disconnected type, weighing upward of 1,180,000 pounds.

The Brooks Locomotive Works last month shipped to the Jefferson & Clearfield Coal & Iron Company a four-wheel saddle tank engine, with 8 by 12-inch cylinders for use at that company's coke ovens. The total weight of the engine is 23,000 pounds.

Cast steel trucks and body bolsters made by the Shickle, Harrison & Howard Iron Company will be used for 280 box cars for the National Linseed Oil Company, which are now nearing completion at the works of the Missouri Car and Foundry Company.

The Rand Drill Company has recently received contracts for compressors from the Cleveland Shipbuilding Company, Cleveland, O.; the Wolverine Copper Mining Company, of Michigan, and from the Ball Brothers Glass Manufacturing Company, Muncie, Ind.

The Westinghouse Electric and Manufacturing Company has been figuring on a contract to supply the electrical equipment for an underground railroad to be built in Johannesburg, Africa. It is reported that the concern has good prospeots tor securing the contract.

The United States Wind Engine & Pump Company, of Batavia, Ill., has completed a 100-foot tower, carrying a 30-foot windmill, for furnishing water supply to the Buffalo & St. Mary's Railroad. They are also supplying the water cranes, etc. The water is pumped from an artesian well 250 feet deep.

The Morgan Engineering Co mpany, of Alliance, O., has recelved a contract for three electric traveling cranes from Jones & Laughlins, Limited, to be placed in the American Iron and Steel Works of that concern in Pittsburgh. Two of them will have a span of 40 feet, and the third ot 80 feet, and each is of 10 tons capacity.

The Pennsylvania Railroad has awarded to the B. Hillman Ship and Engine Building Company, of Philadelphia, a contract for a new ferryboat of the same type and size as the *St. Louis*, recently built by the same firm. The new boat will be named the *New Brunswick*. It will be put into service on the company's new Twenty-third Street Ferry in New York.

The asphalt car roofing manufactured by the Drake & Wiers Company, of Cleveland, O., has been in successful use for the past 15 years and is claimed to be the only genuine asphalt car roofing in the market. It is now in use on over 50,000 cars. The Drake & Wiers Company are the pioneers in this class of car roofs, and are the only manufacturers who are willing to give a 10 years' guarantee of their roofs.

Robert W. Hunt & Company, The Rookery, Chicago, have been given the inspection of the material and construction of the 21 locomotives purchased by the Mexican Central Railway Company from the Brooks Locomotive Works. This concern is also engaged upon the inspection of the material and construction of 50 cattle cars for the San Francisco & San Joaquin Valley Railway Company, and 180 freight cars for the Colorado Midland Railroad Company, both orders being at the Pullman Works.

The Ingersoll-Sergeant Drill Company has recently received orders from the Atchison, Topeka & Santa Fe system for two crosscompound duplex air compressors, one of which goes to the Galveston shops of the G., C. & S. F., and the other to the Albuquerque shops of the A. & P. The same firm has an order for a large Duplex air compressor from the Chicago, Indianapolis & Louisville Railway for its shops at Lafayette, Ind. Both the steam and air cylinders of this compressor will be cross compound, and proportioned for a steam and air pressure of 125 pounds. The capacity of this machine will be 900 cubic feet of free air per minute.

The order for the 600 cars for the Pittsburgh, Bessemer & Lake Erie Railroad, mentioned last month, has been given to the Schoen Pressed Steel Company, of Pittsburgh. The order is a notable one, as the cars are to be of steel, 300 to be built from designs furnished by engineers of the Carnegie Steel Company, and 300 from the designs of Mr. Chas. T. Schoen. One-half of the cars will be equipped with the Schoen Pressed Steel Company's design of truck, and of the balance 200 are to be equipped with Fox truck, 50 with the Kindl, 30 with the Cloud, 10 with the Goltra and 10 with the Vogt truck. The cars are all to be of 100,000 pounds' capacity.

In addition to the twenty-one locomotives which the Brooks Locomotive Works are building for the Mexican Central Railway, they have under construction four 16 by 22-inch side tank passenger locomotives for the Koya Railway, of Japan; two 18½ by 24-inch American type passenger locomotives and two 6-wheel switching locomotives for the Chicago, Indianapolis & Louisville; three 18 by 26-inch American type passenger locomotives for the St. Lawrence & Adirondack Railway; two 10-wheel passenger locomotives for the Burlington, Cedar Rapids & Northern Railway; three moguls for the Pittsburgh, Bessemer & Lake Erie Railway; three Mastodon type freight locomotives for the Buffalo, Rochester & Pittsburgh Railway, and several smaller orders.

A contract has been closed by the Pencoyd Iron Works for 185 steel bridge spans for the Imperial Japanese Railway. This is an important fact, not on account of the size of the order, but because the contract was taken in competition with English and Belgian manufacturers. The price was not a special one, but it was made at the ruling rate for that class of material. It is evidence that the conditions now existing are such that the American steel manufacturers can successfully compete with foreign manufacturers. This is owing to improved mill methods and reduced cost of material in this country, the cost of labor not being a governing element. These, it is said, will be the first bridges built in this country for Japan, and it is believed that this order is but the beginning of an export trade from the United States in steel work for bridges and buildings. The bridges contracted for are for a new line of railways.—Philadelphia Ledger.

The United States Court for the Northern District of Ohio (Judge Taft) has decided the case of the St. Louis Car Coupler Company vs. The National Malleable Castings Company in favor of the latter company, declaring that the Tower coupler was not an infringement of the Lorraine & Aubin reissued patent No. 10,941, June 26, 1888. The three features which were claimed to be covered by this patent were the shape of the knuckle, the position of the pivot pin and the riding of the lock on the tail of the knuckle. The Court held that none of these were novelties in themselves, and that because of the prior state of the art only the narrowest construction must be put upon the claims of the patent. The combination claims were not infringed if a single element were omitted. Several arguments, based on the validity of the reissued patent, were not passed on by the Court, because it was held that even, if valid, there was no infringement of them.

In an article on American and European wheel practice for street railways by Mr. P. H. Griffin, in the Street Raitway Journal, says: There are in America about 14,000 miles of electric railways and 40,000 cars in service, 75 per cent. of the latter having four and about 25 per cent. having eight wheels per car. This makes a total of about 200,000 wheels in this kind of service. Of this total no t I

per cent. are steel or steel tired wheels. It can, therefore, be fairly said that whatever the probabilities are for the use of steel wheels on American electric railways, they have not, up to the present time, made much progress in that direction. This is not stated to the detriment of the steel wheel or its makers, but as a simple fact. It is the opinion of some engineers abroad that the chilled wheel is used in America because it is cheap, but that is far from the fact. American electric railways of the best class do not stop at any expense that will improve service and give better results, and certainly in no country has the development and operation of electric railways been carried to the high standard that it has in this country.

The Pintsch gas buoys used in the St. Lawrence River last year have given such excellent satisfaction that an additional appropriation has been secured from Congress for several more buoys to be placed the coming season. Canadian papers are strongly advocating an appropriation for the purchase of the buoys for Canadian waters. The Pintsch buoy is a compact wrought iron vessel filled with compressed Pintsch gas, and carrying at its top a patent storm proof lantern supported by a strong iron framework. The flow of gas from the reservoir into the lantern is controlled by the Pintsch regulator, by means of which a clear light is maintained, no matter what may be the position of the buoy or how much it may toss in heavy seas. The storm proof lantern is so constructed that while the necessary air is admitted to feed the flame, not a particle of water can enter. The buoys are of various sizes and burn continuously and reliably night and day for from three months to one year, depending on their size. The refilling of a buoy is done from a tender by passing compressed Pintsch gas through a flexible tube into the buoy. This gas is the same as is now used in railroad arc lighting.

The Standard Oil Company are about to erect at Bayonne, N. J., a boiler shop 300 feet long and 105 feet wide. The main portion of the shop is divided into three bays. The central bay, about 50 feet wide, is served with a 15-ton electric crane, supported on heavy girders about 40 feet above the floor. On either side of this main portion is a wing about 30 feet wide. The walls of the building are brick and the supporting frame work is steel. The roofs are to be covered with corrugated iron. The main columns of the shop are 25 feet apart and all arranged so that jib cranes of suitable size and capacity can be attached at any point, which together with the traveling crane in the center will enable them to cover the entire floor surface of the building. One end of the building for a distance about 75 feet in length is supported by clear span trusses which gives a clear floor space over this entire area. In this end of the building will be located fires and furnaces, and other apparatus for heating and shaping the material for the boilers. The building is well lighted by windows in the sides of the brick walls and in the monitors of the roof, and is amply ventilated by means of large monitors on the ridge.

The vises manufactured by the Howard Iron Works, of Buffalo, N. Y., are noted for their great strength, durability, and their excellent construction. The malleable cast-iron nut of the vise is rendered immovable by being set in molten iron, thereby doubling the durablilty of both nut and screw, for they are saved from the destructive grinding, cutting and binding action of the cross-strain, which has always been a great evil heretofore. Another improvement is the chilling of those parts of the slide sheath. that come in contact with the slide, thereby avoiding much friction in its movement. Many additional and important improvements have also been made in their swivel vise. There is great strength in its circular base, so that its side parts may be employed for light anvil uses. The vise is held fast to bench by a very simple cam arrangement, holding it so firmly that the combined force of several men exerted upon the vise cannot move it from position; and yet so conveniont is the arrangement that this great power is instantly removed and applied. The seat of the swivel is slightly concave, so that it shall rest upon the circumference of its base. Their universal combination vises are very handy mechanical appliances for general use, as they combine two different and separate vises in one. They are made very strong, and will swivel in any direction. The "Combination Pipe and Metal Workers' Vise" will be found a very useful and practicable instrument in every engine-room, etc., as the engineer with the aid of a few pipe tongs and die plates, can in most cases do all the small repairing and fitting of pipes, etc., himself. The Howard Iron Works have recently issued a neat folder descriptive of these and other vises of their manufacture.

Our Directory

OF OFFICIAL CHANGES IN APRIL.

We note the following changes of officers since our last issue. Information relative to such changes is solicited.

Mobile & Ohio.—Mr. E. L. Russell has been elected Vice-President.

Brooklyn Elevated.—Mr. F. K. Ulman has been appointed Receiver.

Plant System.—Mr. J. F. Sheahan, Master Mechanic at Palatka, Fla., has resigned.

Kansas City, Pittsburgh & Gulf.—President E. L. Martin has resigned, and Vice-President A. E. Stillwell succeeds him.

Wilmington, Newbern & Norfolk.—Vice-President H. A. Whiting has been appointed Receiver.

Fall Brook.—Col. John Magee has been elected President, to succeed Gen. G. J. Magee, deceased.

Allegheny & Kinzua.—Mr. F. W. Kruse has been appointed Receiver, vice Mr. A. D. Scott.

Rio Grand Western.—Mr. John Hickey has been appointed General Master Mechanic, with office at Salt Lake City.

Fonda, Johnstown & Gloversville Railroad.—The Hon. James Shanahan, President of the Fonda, Johnstown & Gloversville Railroad, died on March 12, 1897.

Gainesville, Jefferson & Southern.—Mr. S. C. Dunlap has been appointed Receiver, vice Mr. Martin H. Dooly.

Wadley & Mt. Vernon Railroad.—Mr. T. J. James has been elected President.

Mexican Central.—Mr. H. Ridgeway has been appointed Master Mechanic at Chihuahua, vice Mr. T. Smethurst, resigned.

Ann Arbor.—Mr. O. D. Richards is appointed Chief Engineer, vice Mr. G. A. Nettleton, resigned.

Kansas City & Northern Connecting.—Mr. T. C. Sherwood has been appointed General Manager.

Houston, East & West Texas.—Mr. E. B. Cushing has been appointed Chief Engineer.

Roaring Creek & Charleston.—Mr. Thomas Fisher has been appointed Receiver, vice Mr. C. T. Dixon, resigned.

Lehigh Valley.—Mr. F. F. Gaines has been appointed Mechanical Engineer, vice Mr. H. D. Taylor, promoted.

Lexington & Eastern.—Mr. Geo. F. Foster has resigned as Master Mechanic and the office is abolished. Mr. E. R. McCuen has been appointed General Foreman in charge of Mechanical Department. Headquarters, Lexington, Ky.

Dunkirk, Allegheny Valley & Pittsburgh.—The position of Master Mechanic, made vacant by the death of Mr. W. G. Tabor, has been abolished. Mr. A. Sherman is Foreman of Repairs at Dunkirk, N. Y.

St Louis & Cairo.—Mr. F. A. Horsey has been elected President, vice Mr. J. H. Horsey, deceased.

Philadelphia & Reading.—Mr. Albert Foster, Purchasing Agent, died April 10.

South Beach.—Mr. Chas. A. Beach has been chosen General Manager.

Carolina & Northwestern.—Mr. G. W. F. Harper has been chosen President.

Gulf, Colorado & Santa Fe.—Mr. L. J. Polk, Acting General Manager, has been made General Manager.

Cornwall.—Mr. D. S. Hammond, Purchasing Agent, died on April 3.

Queen Anne.—Mr. I. W. Troxell has been chosen General Manager. Office, Queenstown, Md.

Oregon Short Line.—Mr. J. F. Dunn is Superintendent of Motive Power and Ira O. Rhodes, Purchasing Agent.

Eastern of Minnesota.—General Manager W. C. Farrington has resigned and Vice-President J. N. Hill will perform the duties of the office.

Atlantic & North Carolina.—Mr. Robert Hancock has been elected President.

Norfolk & Western.—Mr. Joseph H. Sands has resigned as General Manager and the duties of the office will be performed by Vice-President J. M. Barr.

Chicago & Northwestern.—Mr. W. H. Marshall is appointed Assistant Superintendent of Motive Power and Machinery, with office in Chicago.

Chicago, Burlington & Quincy.—Master Mechanic Mr. Joel West died March 23d. Master Mechanic C. W. Eckerson died April 9th. Mr. J. F. Deems has been transferred from Ottumwa to Beardstown. Mr. J. E. Button has been appointed Master Mechanic at Ottumwa.

New Albany, Lebanon & Sodaville.—Mr. M. W. Wilkins is President, with headquarters at Waterloo, Oregon.

Chicago & Grand Trunk.—Mr. George Masson, chief engineer, has resigned. Mr. J. W. Harkom has been appointed Master Mechanic of the Eastern Division with office at Montreal; Mr. W. D. Robb, Master Mechanic, of the Middle Division, with office at Toronto, and Mr. Wm. W. Ball, Master Mechanic of the Northern Division, with office at Allandale, Ont.

Atchison, Topeka & Santa Fe.—Mr. W. E. Hodges has been appointed Purchasing Agent, vice Mr. W. G. Nevin, resigned.

Southern California.—Mr. W. G. Nevin, formerly Purchasing Agent of the A., T. & S. F., has been chosen General Manager, vice Mr. K. H. Wade, deceased.

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

JUNE, 1897.

CONTENTS.

Ten-Wheel Compound Passenger Locomotive—Northern Pacific Railway.

Two interesting designs of compound locomotives which have recently been built by the Schenectady Locomotive Works for the Northern Pacific Railway were described in the March and April issues of the current volume of this journal, and by courtesy of Mr. E. M. Herr, Superintendent of Motive Power of the road, and Mr. A. J. Pitkin, Vice-President and General Manager of the building works, the general dimensions and description of the third design are presented. The first of the series was a 12-wheel or mastodon freight locomotive, the second a 10-wheel freight and the third is of the 10-wheel passenger type. All three are noteworthy. The boilers and heating surfaces are large; in no case is the heating surface less than 2,485 square feet and the steam pressures used are 200 pounds in all three. The strength of the frames and the attention given to the securing of the cylinders, as well as the care which was taken to put the weight into the boilers and save weight in other parts, constitute other features of special interest. The results of the generous supply of boiler power will be eagerly watched by those who are finding difficulty in securing sufficient steaming capacity for the increasing requirements of heavy fast service.

The general appearance of the locomotives is shown and the boiler and frame may be examined in the accompanying engravings. An item of interest in the boiler is the tapering of the back end, which is clearly shown in the smaller engraving. The back head is 6 inches smaller in diameter than the portion of the boiler upon which the dome is placed. This was done in order to keep the weight upon driving wheels within the specified limits. Cast steel has been freely used, and the crank pins, rocker shafts and valve stems are all made hollow to contribute to this result. The chief use of cast steel is in the driving wheel centers, the foot plates, expansion plates, driving boxes, guide yoke knees, rocker shafts, crossheads and frame filling. The crankpins are nickel steel. The weight saved in this way was utilized in getting the maximum possible heating surface in the boiler. The grate area has not been slighted, it being 30.8 square feet. The ratio between the heating surface and the grate area is nearly 81 to 1. The boiler work is specially good. The riveting was all done by hydraulic power, and all of the flanging on the boiler as well as the forming of the smokebox front and door and of the cylinder and steam chest casings was done on a hydraulic press.

General Dimensions.

Gage	4 feet $8\frac{1}{2}$ inches
Fuel	Bituminous coal
Weight in working order	(150,600 pounds) 155,500 pounds
" on drivers	(112,000 ") 112,000 "
Wheel base, driving	14 feet 10 inches
" " rigid	14 feet 10 "
" " total	25 feet 10 "

Cylinders.

Diameter of cylinders	(20 inches) L. P., 31 inches; H. P. 22 inches
Stroke of piston	(26 inches) 26 inches
Horizontal thickness of piston	$5\frac{3}{4}$ inches and $4\frac{3}{4}$ inches
Diameter of piston rod	$3\frac{1}{2}$ "
Kind " " packing	Cast iron
" " " rod packing	Jerome metallic
Size of steam ports	(20 inches by $2\frac{1}{8}$ inches) L. P. 23 inches by $2\frac{1}{8}$ inches, H. P. 20 " " " "
" " exhaust ports	(20 inches by 3 inches) L. P. 23 inches by 3 inches, H. P. 20 " " 3 "
" " bridges	$1\frac{3}{4}$ inches

Valves.

Kind of slide valves	Allen-American
Greatest travel of slide valves (6 inches)	$6\frac{1}{2}$ inches
Outside lap of slide valves (1⅛ ")	L. P., $1\frac{1}{4}$ inches; H. P., $1\frac{1}{8}$ "
Inside clearance of slide valves (⅛ ")	$\frac{1}{4}$ "
Kind of valve stem packing	Jerome metallic

Wheels, etc.

Diameter of driving wheels outside of tire	69 inches
Material " " centers	Cast steel
Tire held by	Shrinkage
Driving-box material	Cast steel
Diameter and length of driving journals	9 inches on main only; $8\frac{1}{2}$ inches on F. and B., by 11 inches
" " " main crank pin journals	6 inches diameter by 6 inches
" " " side rod crank pin journals	Main pin, $6\frac{1}{2}$ inches by $5\frac{1}{4}$ inches F. and B., 5 inches by $4\frac{1}{4}$ inches
Engine truck, kind	Four-wheel, swing bolster
" " journal	6 inches diameter by 11 inches
Diameter of engine truck wheels	33 "
Kind of engine truck wheels	Standard, steel-tired, wrought-iron spoke center

Boiler.

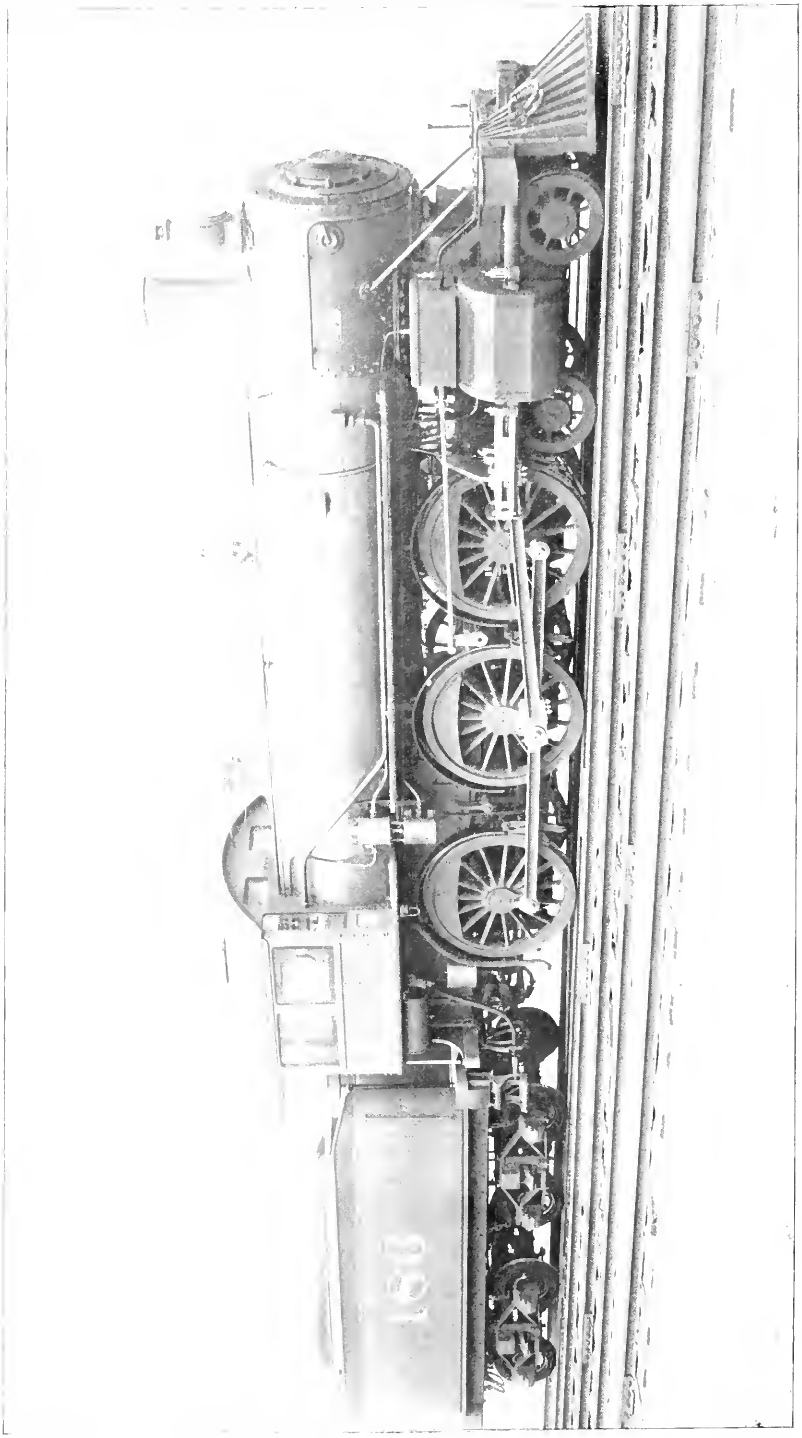
Style	Extended wagon top
Outside diameter of first ring	62 inches
Working pressure	200 pounds
Material of barrel and outside of firebox	Carbon steel
Thickness of plates in barrel and outside of firebox,	$\frac{5}{8}$ inch, $\frac{11}{16}$ inch, $\frac{1}{2}$ inch and $\frac{7}{16}$ inch
Horizontal seams, butt joint,	sextuple riveted, with welt strip inside and outside
Circumferential seams	Double riveted
Firebox, length	$108\frac{3}{16}$ inches
" width	41 inches
" depth	Front 76 inches, back 64 inches
" material	Carbon steel
" plates, thickness, sides	$\frac{5}{16}$ inches; back, $\frac{5}{16}$ inches; crown, $\frac{3}{8}$ inches, tube sheet, $\frac{1}{2}$ inch
" water space,	$4\frac{1}{2}$ inches to 5 inches at 24 inches height, front, $3\frac{1}{2}$ inches to 4 inches above grate sides, $3\frac{1}{2}$ inches to $4\frac{1}{2}$ inches at crown back
" crown staying	Radial stays $1\frac{1}{8}$-inch diameter
" stay bolts	Ulster special iron 1 inch diameter
Tubes, material	Charcoal iron No. 12 W. G.
" number of	314
" diameter	2 inches
" length over tube sheets	14 feet
Firebrick, arch supported on	Four water tubes
Heating surface, tubes	2,288.02 square feet
" " water tubes	28.95 square feet
" " firebox	168.03 square feet
" " total	2,485.00 square feet
Grate "	30.8 square feet
" style	Rocking, Railroad Company's style
Ash pan "	Hopper, with dampers F. & B.
Exhaust pipes	Single, high
" nozzles	(5 in., $5\frac{1}{4}$ in., $5\frac{1}{2}$ in.) $5\frac{1}{4}$ in., $5\frac{1}{2}$ in. and $5\frac{3}{4}$ in. diameter
Smokestack, inside diameter	19 inches at top, 16 inches near bottom
" top above rail	14 feet $9\frac{3}{4}$ inches
Boiler supplied by	Two injectors, Sellers improved, Class M., No. $9\frac{1}{2}$

Tender.

Weight, empty	37,860 pounds
Wheels, number of	8, standard, steel-tired, wrought iron plate center
" diameter	33 inches
Journals, diameter and length	$4\frac{1}{2}$ inches diameter by 8 inches
Wheel base	15 feet 3 inches
Tender frame	10-inch steel channels
" trucks	four-wheel, channel iron, center bearing F. and B.
Water capacity	4,350 U. S. gallons
Coal "	9 (2,000 pounds) tons
Total wheel base of engine and tender	52 feet 2 inches
" length " " "	61 feet 4 inches

The design was prepared by Mr. Herr in consultation with the engineering department of the builders. The general dimensions of the design are given in the appended table and the figures in parentheses are the dimensions of a 10-wheel simple locomotive which is a duplicate of the compound in every respect excepting as to the dimensions thus indicated.

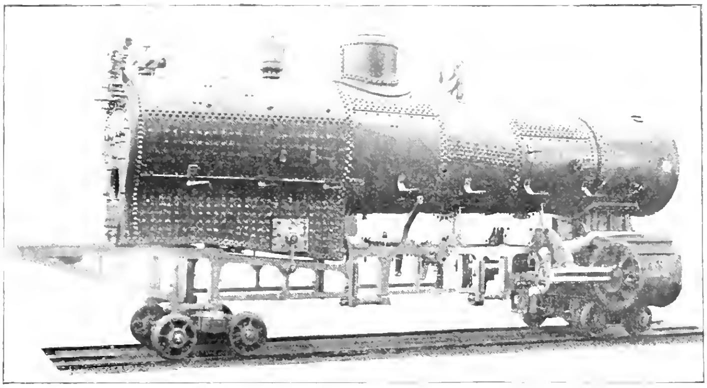
Among the fittings used are two 3-inch Ashton safety valves, the American brake on all drivers, the Westinghouse brake on



COMPOUND TEN-WHEELED PASSENGER LOCOMOTIVE—NORTHERN PACIFIC RAILWAY.

E. M. HERR, *Superintendent of Motive Power.* *Built by the* SCHENECTADY LOCOMOTIVE WORKS.

tender and train, the Westinghouse air signal, Kewanee reversible brake beam, the Star 16-inch round case headlight, Crosby 6-inch chime whistle, Le Chatelier water brake, a double riveted mud ring, one McIntosh blow-off cock, Dean's sanding device, a spring buffer between the locomotive and tender, and the Consolidated car-heating apparatus with Sewell couplings. The table records the principal dimensions and includes details not already mentioned.



Boiler for Northern Pacific 10-Wheeled Compound Locomotive.

The Steam Turbine.

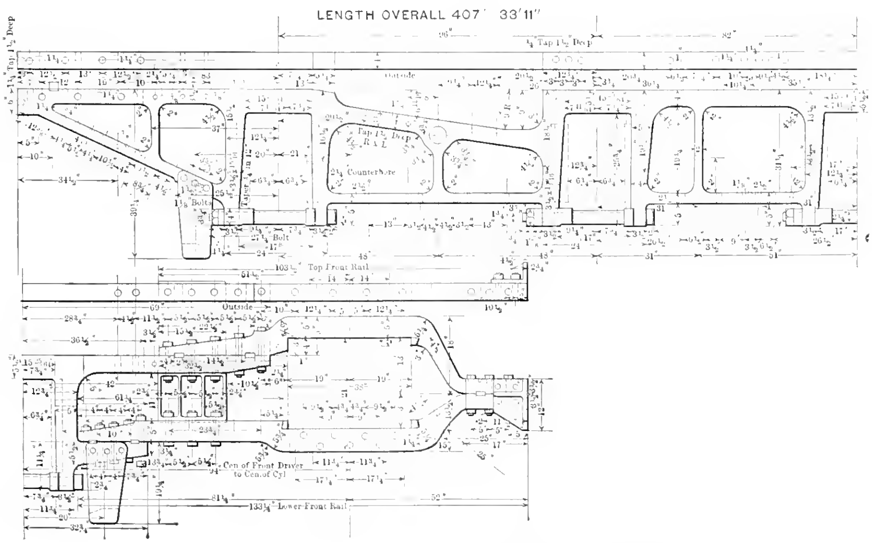
The application of the steam turbine to the operation of electric dynamos and to marine propulsion has attracted a large amount of interest. In the May issue of this journal the announcement was made of the unprecedented speed record of 32¾ knots an hour having been made by the *Turbinia*, the experimental boat fitted up for trying the powers of the steam turbine for marine uses. The record has been satisfactorily confirmed, and it warrants confident expectations of developments on a large scale in the new field. We reprint portions of a paper by Mr. Charles Parsons, inventor of the turbine used in these in these trials, which was recently read before the Institution of Naval Architects. The paper was read before the most remarkable of the records were made:

The manufacture of the compound steam turbine was first commenced in the year 1885, with the construction of small engines for the driving of dynamos; successive improvements were made, and larger engines constructed, but up to the year 1892 the consumption of steam was not such as to justify the application of this class of engine to the purpose of marine propulsion, though, on account of its light weight small size, and high speed of revolution, it presented great advantages over ordinary engines for certain classes of work.

In the year 1892, however, a highly developed compound turbine, adapted for condensing, was constructed for the Cambridge Electric Supply Company, and when tested by Professor Ewing, F. R. S., showed a consumption of steam equivalent to 15.1 pounds per indicated horse-power per hour, the boiler pressure being 100 pounds, and the steam superheated to 127 degrees F. above the point of saturation.

More recently componud turbine engines have been constructed up to 900 horse-power, both condensing and non-condensing, and consumptions of steam as low as 14 pounds per indicated horse-power with saturated steam, and 100 pounds boiler pressure, have been ascertained in engines of 200 horse-power, and still lower consumptions in engines of larger size. Many of the original engines are still doing good work; some, especially the larger sizes of 500 horse-power and upward, are frequently kept at work for several weeks without stopping. The returns of the Newcastle and District Electric Lighting Company show a yearly cost of upkeep of 2½ per cent. per annum, and the total horse-power of turbines now at work in England exceeds 30,000 horse-power.

In January, 1894, a syndicate was formed to test thoroughly the application of the compound steam turbine to marine propulsion, and a boat was designed for this purpose. The *Turbinia*—as the boat is named—is 100 feet in length, 9 feet beam and 44½ tons displacement. The original turbine engine fitted in her was designed to develop upward of 1,500 actual horse-power at a speed of 2,500



Frames for Northern Pacific 10-Wheeled Compound Locomotive.

revolutions per minute. The boiler is of the water-tube type for 225 pounds per square inch working pressure, with large steam space, and large return water legs, and with a total heating surface of 1,100 square feet, and a grate surface of 42 square feet; two firing doors are provided, one at each end. The stokeholds are closed, and the draught furnished by a fan coupled directly to the engine shaft. The condenser is of large size, having 4,200 square feet of cooling surface; the circulating water is fed by scoops, which are hinged and reversible, so that a complete reversal of the flow of water can be obtained should the tubes become choked. The auxiliary machinery consists of main air pump and spare air pump, auxiliary circulating pump, main and spare feed pumps, main and spare oil pumps, also the usual bilge-ejectors: the fresh-water tank and hot well contain about 250 gallons.

The hull is built of steel plate, of thickness varying from $\frac{3}{16}$ inch in the bottom to $\frac{1}{16}$ in the sides near the stern, and is divided into five spaces by water-tight bulkheads.

The approximate weights are:

	Tons.
Main engines	3 tons 13 cwt.
Total weight of machinery and boiler, screws and shafting, tanks, etc	22
Weight of hull complete	15
Coal and water	7½
Total displacement	44½

Trials were made with screws of various patterns, but the results were unsatisfactory, and it was apparent that a great loss of power was taking place in the screw.

The single compound turbine engine was now removed from the boat and replaced by three separate compound turbines, directly coupled to three screw shafts, working in series on the steam, the turbines being the high-pressure, intermediate, and low-pressure, and designed for a complete expansion of the steam of 100-fold, each turbine exerting approximately one-third of the whole power developed, the three new screw shafts being of reduced scantling. By this change the power delivered to each screw shaft was reduced to one-third, while the division of the engine into three was favorable to the compactness and efficient working of the turbines. The total weight of engines and the speed of revolution remained the same as before. The effect on the screws was to reduce their scantling, and to bring their conditions of working closer to those of ordinary practice. The thrust of the propellers is balanced by steam pressure in the motors. The rest of the machinery remains the same, though some changes in arrangement were necessary.

At all speeds the boat travels with an almost complete absence of vibration, and the steady flow of steam to the motors may have some influence on priming; at any rate, no sign of this has yet occurred with ordinary Newcastle town water. No distilling apparatus has been fitted. The boat has been run at nearly full speed in rough water, and no evidence of gyroscopic action has been observable.

The oiling of the main engines is carried on automatically under a pressure of 10 pounds per square inch by a small pump worked off the air-pump engine; a small independent duplex oil pump is also fitted as stand-by. The main engines require practically no attendance beyond the regulation of a small amount of live steam to pack the glands and keep the vacuum good.

The advantages claimed for the compound steam turbine over ordinary engines may be summarized as follows:

1. Increased speed.
2. Increased economy of steam.
3. Increased carrying power of vessel.
4. Increased facilities for navigating shallow waters.
5. Increased stability of vessels.
6. Increased safety to machinery for war purposes.
7. Reduced weight of machinery.
8. Reduced space occupied by machinery.
9. Reduced initial cost.
10. Reduced cost of attendance on machinery.
11. Diminished cost of upkeep of machinery.
12. Largely reduced vibration.
13. Reduced size and weight of screw propellers and shafting.

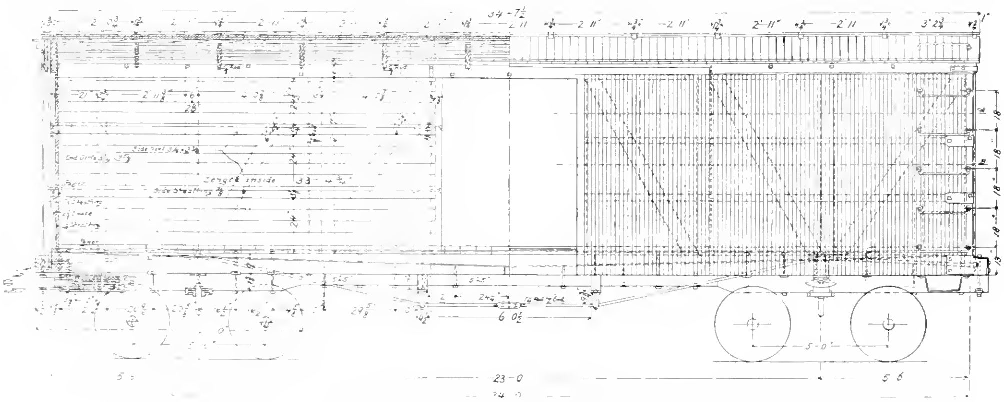
In December of last year several runs were made on the measured mile, and the maximum mean speed obtained after due allowance for tide was 29.6 knots, the mean revolutions of the engines being 2,550 per minute. Since then new propellers of increased pitch ratio have been fitted.

Further trials were made on April 1. The mean of the two consecutive runs gave a speed of 31.01 knots, the mean revolutions of the engines being 2,100 per minute, the fastest run being at the rate of 32.61 knots.

The utmost horse-power required to drive the boat at the speed of 31.01 knots is 946, as calculated from experiments on her model, made at Heaton Works, on the method of the late Mr. William Froude. Assuming the ratio of thrust horse-power to indicated horse-power to be 60 per cent. (which appears to be the ascertained ratio for torpedo-boats and ships of fine lines), the equivalent indicated horse-power for 31.01 knots is 1,576.

Conditions of Running of "Turbina" at 31.01 Knots Speed.

Mean revolutions of engines	2,100
Steam pressure in boiler	200 pounds
Steam pressure at engines	130 pounds
Vacuum at exhaust of engines	13½ pounds
Speed of boat	31.01 knots
Calculated thrust horse-power	946
Calculated indicated horse-power	1,576
Consumption of steam, reduced to basis of 31.01 knots	25,000 pounds
Consumption of steam per indicated horse-power per hour	15.86 pounds
Total weight of machinery, including boiler, condensers, engines, auxiliaries, shafting, propellers, tanks, water in boiler and hot-well, in working order	22 tons
Indicated horse-power per ton of total machinery	72.1



Special Ice Car C. & N. W. Railway. Fig. 1.—Half Section and Elevation.

Designed by C. A. Schroyer, Superintendent Car Department.

Ice Car—Chicago & Northwestern Railway.

The ice traffic on many roads is handled by means of the ordinary box cars, and usually the best of cars are not selected for this purpose, but rather the nearly worn-out equipment. The severity of usage which cars receive in hauling ice soon finishes them, unless they are specially reinforced for the purpose. The Chicago & Northwestern Railway has recently received a lot of 400 cars from the Haskell & Barker Car Company, which were built to designs prepared by Mr. C. A. Schroyer, Superintendent of the car department of the road, for the special service of ice

transportation. The ice trade does not last long enough to warrant the use of cars exclusively for this work, and they are also adapted to hauling grain and coal. The special features of the cars are the strengthening of the upper framing, with particular reference to the ends, the arrangement for the draining of the cars, yet insuring a water-tight floor, and other details which go to make up a strong construction for resisting the shocks due to a load which shifts easily. Through the courtesy of Mr. Schroyer the accompanying engravings were prepared from the working drawings. A half longitudinal section and elevation is shown in Fig. 1, an end section in Fig. 2 and a detail section of the floor in Fig. 3.

The length of the car over sills is 34 feet, the width is 8 feet 9 inches, the height of posts 6 feet 7 inches, the length inside 33 feet 4¾ inches, the carrying capacity is 60,000 pounds, the volume is 1,873 cubic feet, the weight is 32,000 pounds. The car has six sills, as shown in Fig. 3—being of Southern pine, 5 by 9 inches in section, and at the doors short intermediate sills are added, which are 2½ by 9½ inches in section and rest on the cross-tie timbers. The end sills are 8 by 9 inches of white oak. The

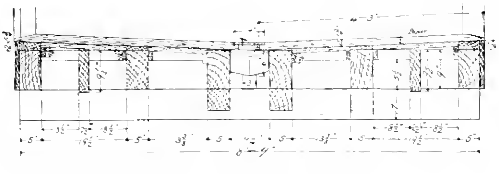


Fig. 3.—Section of Floor.

draft timbers are white oak, 5½ by 7¾ inches, and are reinforced by 5 by 5 inch Southern pine timbers, placed under the center sills and between the draft timbers, as shown in Fig. 1. The floor is double, the subflooring being of pine, ⅞ by 5¼ inches, nailed to ⅞ by 1¼-inch cleats. A course of sheathing paper is laid over the subfloor, as indicated in Fig. 3. The top floor course is 1¾ inches thick, tongued and grooved, and after being laid was given a heavy coat of white lead to secure water tightness. The floor slopes each side of the center to drain into a trough which extends the length of the car, and is of No. 24 galvanized iron riveted up and nailed to the center sills, as shown in Fig. 3. The trough is covered by a ⅜ by 7-inch plate of wrought iron. There is nothing unusual about the sheathing and lining. Paper insulation is provided under the lining, which extends the full height of the car. The C. & N. W. standard grain door is used, having an extension or leaf upon its top and connected by hinges to the body of the door. The main portion of the door is 3 feet 6 inches high, and the hinged portion is 15½ inches high, making the total height of the door 4 feet 9½ inches.

The body bolsters are of steel, 7 inches wide. The truss rods, four in number, are of 1¼-inch iron with 1½-inch ends connected by turn buckles made by the Cleveland City Forge and Iron Company. Chicago steel couplers are used. The draft springs are arranged in tandem, as shown in Fig. 1. The brakes were furnished by the Westinghouse Air Brake Company. The paint used is known as C. & N. W. No. 1 mineral paint and was furnished by the railroad company. The brake beams are of 4 by 4-inch oak with ⅞-inch truss rods, which is the standard of the road. The trucks are also the standard pattern used under 30-ton cars on this road. They are of the diamond frame swinging-link type with straight pedestal tie bars and outside hung brakes. The strengthening of the car ends, previously mentioned, consists of the use of corner posts 3¾ by 4¼ inches, end posts 4¼ by 5⅞ inches. The belt rails or girts are double, those on the sides being 3¼ by 3⅜ inches and those on the ends are 3¼ by 3⅜ inches. The cars are painted a light color and are pleasing in appearance.

A New Experimental Locomotive for Purdue University.

In a recent communication Professor Goss, of Purdue University, states that the laboratory equipment of that institution is to be improved by the acquisition of a new locmootive, a contract for the building of which has just been placed with the Schenectady Locomotive Works.

The new locomotive will possess a number of features which are quite novel. It will carry a steam pressure of 250 pounds per square inch and will have cylinders so arranged that it may be used as a simple or a compound. The cylinders and the saddle will be made up of different castings and the centers will be so chosen as to allow the use of cylinders up to 30 inches in diameter. Several cylinders will be provided, and these, with a suitable series of

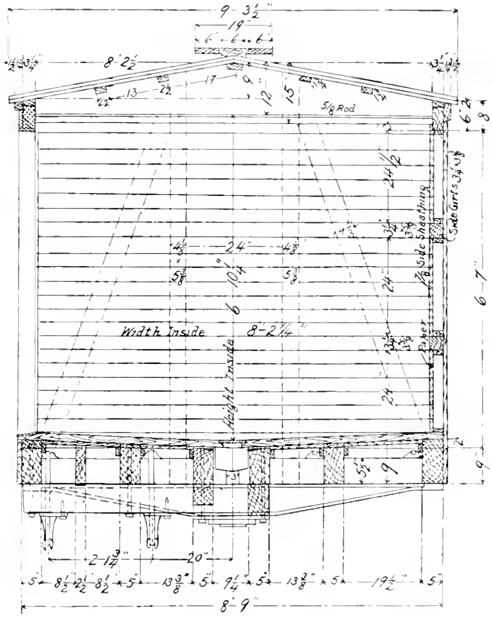


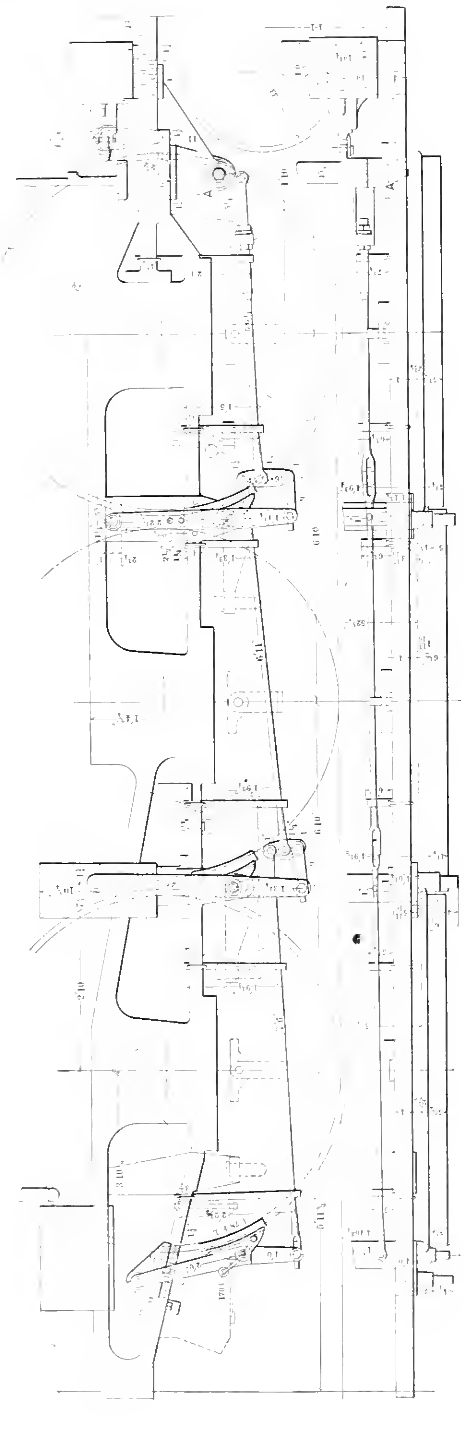
Fig. 2.—Transverse Section.

bushings, will allow for different cylinder ratios in compound work. The whole machine will thus afford facilities for dealing with conditions quite beyond the limits of present practice.

From its place in the laboratory, the old locomotive, hereafter to be known as "Schenectady No. 1," and which in the course of its six years' sojourn in the lebaratory has been run an amount equivalent to 20,000 miles, and has served in an experimental study of many important problems connected with locomotive design, will pass into active service, pulling trains on the road, while the new engine, "Scenectady No. 2," will take its place upon the testing plant.

By the terms of the contract, the present engine "Schenectady No. 1" will be delivered to the Schenectady Locomotive Works within the present month, and the new engine, "Schenectady No. 2," will be delivered early in the fall.

A large amount of data derived from "Schenectady No. 1" during the past year will soon be issued from the laboratory, and as soon as practicable all of the papers descriptive of work accomplished in connection with this engine will be published in a single volume.



NEW DRIVING WHEEL BRAKE ARRANGEMENT, BALTIMORE & OHIO RAILROAD.

Driving Brake Arrangement, B. & O. R. R.

Through the courtesy of Mr. Harvey Middleton, General Superintendent of Motive Power of the Baltimore & Ohio Railroad and the officers of the American Brake Company, the accompanying illustration is presented, showing a new arrangement for driving-wheel brake rigging for a 10-wheel locomotive. The engraving presents the design in such a way as to require little description beyond a statement of the reasons for using this arrangement. The novelty of the plan consists in a complete reversal of the usual arrangement for locomotive driving-whee brakes. The whole apparatus has been turned around and the cylinders are placed between the frames back of the cylinder saddle. The locomotive is close coupled with 78-inch driving wheels, the size of which left little opportunity for securing the cylinders upon the outside of the wheels in the usual way. Aside from this the plan followed offers several important advantages. The cylinders of the brake rigging are in a protected position, and are not liable to injury in case of accident. The brakeshoes are applied upon the rear sides of the driving-wheel tires, which upon the application of the pressure forces the boxes up against the pedestal shoes instead of against the wedges, as is the case in the ordinary applications. With a push cylinder applied to this type of engine it is a difficult matter to locate the cylinder properly without using a long connection between the piston rod and the brake lever and the parts must be made very heavy to avoid buckling when such an arrangement is used. The cylinders shown in this engraving operate by pushing and the design gives a very substantial connection to the brake levers.

The brake is operated by the Westinghouse Air-Brake Company's triple valve known as E 38 and the auxiliary reservoir employed is 14 by 33 inches. The cylinders are known as No. 15 B. and are 12 by 10 inches in size. The weight upon the driving wheels is 113,000 pounds, the braking power being 84,750 pounds. The cylinders are mounted upon a 1½ by 12-inch plate which extends across the frames and is bolted to them. The equipment was furnished by the American Brake Company, the Westingbouse Air-Brake Company lessee.

THE EFFICIENCY OF STEAM ENGINES.

BY A PROMINENT MASTER MECHANIC.

The various standards or ideals that have been employed in computing the efficiency of steam engines have led to more or less confusion, at least in the minds of those who have not delved very deeply into thermodynamics, and inaccuracy or carelessness of statement is not wholly absent from the writings of those who are supposed to have a clear conception of what the various efficiencies of an engine really are. Some writers have severely condemned the employment of so many standards of comparison, and yet it must be admitted that most of these standards are of value in pursuing certain lines of investigation. The only difficulty arising from the present condition of affairs is in the wrong use to which some of the standards are put. For instance, we read in an article that is presumably addressed to owners or operators of power plants that "there is a limit to the performance of every kind of heat engine which cannot be exceeded, however perfect its construction may be. In the case of a condensing steam engine in which the drip from the condenser is returned to the boiler, the greatest possible efficiency is expressed by the fraction

$$\frac{T - t}{T + 460^{\circ}}$$

A similar limitation is set by nature on every imaginable form of motor which transforms heat energy into mechanical energy. This is all true and yet the truth is so presented as to lead a not over-careful reader to the conclusion that the commercial efficiency of a steam engine is or can be made as great as any other form of heat engine, or that all steam engines working between the same temperatures are to be placed in the same category—conclusions not warranted by the actual facts.

In considering briefly several standards of efficiency we will take up first the one expressed by the formula quoted above. It

is the efficiency of an ideal engine working on the Carnot cycle. An engine working on this cycle receives all of its heat at the higher temperature and rejects it all at the lower temperature. It is the most generally accepted standard of comparison, and yet it is an ideal absolutely impossible of realization. We cannot put in all the heat at the higher temperature. Furthermore, in this formula the denominator is the temperature of the steam above absolute zero—460 degrees below zero Fahrenheit. As it is physically impossible to take sufficient heat out of the working fluid to reduce its temperature to absolute zero—the lowest conceivable—we are making a comparison as foolish for commercial purposes as though we calculated the potential energy of masses on the basis of their distance from the center of the earth rather than from its surface. Consequently, however valuable this standard may be for scientific purposes, or as a guide to the designer, it is of little value in other directions.

The Clausius cycle differs from the one just described, in that the feed is raised from exhaust to admission temperature, evaporated at constant temperature to dry steam, expanded adiabatically to back pressure, and the heat rejected at the temperature of back pressure. Both of these cycles are used to indicate the performance of the ideal engine between the limits of the temperature of the actual engine. Then the efficiency of the actual engine may be expressed by the ratio its performance bears to that of the ideal.

To be more definite, let us take the case of an engine whose admission pressure is 175 pounds absolute, corresponding to a temperature of 370 degrees Fahr., and whose condenser pressure is 1.25 pounds absolute, corresponding to a temperature of 110 degrees Fahr. The efficiency of the ideal engine working on the Carnot cycle is

$$\frac{T-t}{T+460} \quad \text{or} \quad \frac{370-110}{370+460} \quad \text{or} \quad .313$$

The formula for the Clausius cycle is more complicated and gives for an ideal engine working within the same limits an efficiency of .284. These efficiencies are on the assumption that the total heat from the higher temperature T to absolute zero is available.

Now let us take the steam consumption of the actual engine at $13\frac{1}{2}$ pounds when operating between the temperatures 370 and 110 degrees Fahr., and let us assume that the feed water is at a temperature of 110 degrees. The actual efficiency of the engine is the ratio between the heat furnished the steam and the heat converted into work. The heat units in a pound of steam at 370 degrees in excess of the heat units in a pound of water at 110 degrees are 11.17, and in the $13\frac{1}{2}$ pounds of steam used by the engine the total heat units supplied number 15,079.5. As one horsepower per hour is the mechanical equivalent of 2,565 heat units, the engine converts into work only $\frac{2{,}565}{15{,}079.5}$, or 17 per cent. of the heat it receives. This is the true efficiency, and we believe it to be the only efficiency of any commercial value. Other efficiencies derived from comparison with various ideals are of value only in comparing engines with a view of determining the effect of certain features of design or operation.

If we compare the actual performance of this engine with the Carnot cycle for the same range of pressures, we find that it utilized $\frac{.170}{.313}$, or 54 per cent. of the heat the ideal engine is supposed to convert into work. Compared with the Clausius cycle, the percentage is 60 per cent. For convenience let us put these in tabulated form:

Efficiency of actual engine	17.0	per cent.
Clausius cycle	28.4	"
Carnot "	31.3	"
$\frac{\text{Actual engine}}{\text{Clausius cycle}}$	54.3	"
$\frac{\text{Actual engine}}{\text{Carnot cycle}}$	60.0	"

In addition to the efficiencies given in the above table, a number of others have been proposed, with a view of furnishing a standard that shall be less of an abstract ideal than either the Carnot or Clausius cycles, and which will be more comparable with the actual engines. To illustrate: In the actual engine, expansion cannot be carried beyond the pressure necessary to overcome the friction of the engine without a loss. A standard has therefore been proposed which differs from the Clausius cycle in that the expansion is not carried down to the back pressure. Others might be cited were it necessary, but it is only needful to remember that the actual commercial efficiency is the only true efficiency, and that all other efficiencies are obtained by comparison with these abstract ideals that have been conceived as aids to an analysis of an engine's performance. If this is kept in mind there will be less confusion of ideas and language.

Furthermore, with the actual efficiency of heat engines in mind, it will not be claimed that steam, hot air, gas and oil engines (working within the same temperature) are capable of the same efficiency from a commercial point of view.

Locomotive Turntable Operated by Electric Motor.

Electric motors have been used for a number of years for the operation of locomotive and car transfer tables, but it is believed that their first application to locomotive turntables is the one under notice. Steam and air motors applied by gearing and by direct traction have been used, and it has been thought that the electric motor was not adapted to direct traction in this connection. The accompanying engravings show the manner of applying an electric motor to the turntable at the West Milwaukee roundhouse of the Chicago, Milwaukee & St. Paul Railway, where the apparatus has been in successful operation for some months.

This roundhouse is located at an important division point, where expedition in handling locomotives in and out of the house

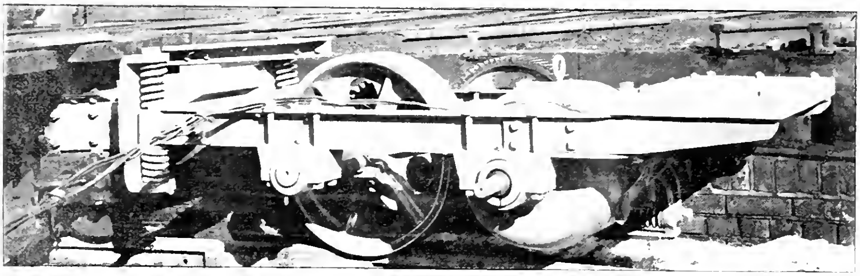
Electric Motor Driving a Turntable.

is very desirable. One hundred and seventy-six engines are turned on this table during each 24 hours, or an average of over seven per hour. Before applying the motor attachment the table was turned by hand by means of push poles set at its ends; the number of men required to turn it was four, and the operation was a very slow one.

By means of the power attachment one man does the work of the four, and in a very much shorter time. The table can be turned a complete revolution, including the start, when light, in 30 seconds; with a 10-wheel engine upon it, weighing with its tender 100 tons, the table can be turned a complete revolution in 45 seconds.

The money saving effected by the device may be figured as follows :

Number of engines turned per day (24 hours)	176
Men required	4
Average time required each man	5 minutes
Total average time lost per engine	20 minutes
Or, per day (24 hours)	59 hours
Present force	one man day and night
Or per day	24 hours
Total daily time saved	35 hours
At 12½ cents per hour	$4.37



Electric Motor and Attachment to Locomotive Turntable.

This is based on the assumption that the men used in turning the table attend to wiping engines when they are not engaged at the table; otherwise, the saving would be much greater. The estimate of five minutes required for each man of the gang away from his work each time an engine is turned is a conservative one, for as a matter of fact, during certain busy hours of the day, the men were at the table practically the entire time.

It will be seen from the foregoing that it is possible to save approximately 35 hours of wipers' time, each 24 hours, or say, two day and two night men, working 8 hours each. Under present conditions at West Milwaukee, it was not considered advisable to drop any of the wiping force, as the time saved could be put in to good advantage in wiping, but an actual reduction in the pay-roll of $3 per day was made in the following manner, without reducing the number of wipers:

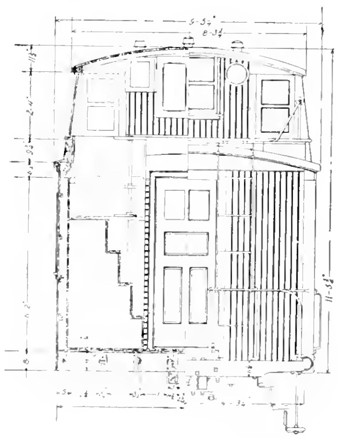
Working on an eight-hour basis, it was necessary morning and night to retain three men four hours, so as to be on hand to turn the table between the times of changing gangs; this made a total of 24 hours' additional labor to be be paid for each day, or, at the rate of 12½ cents per hour, amounting to $3, all of which is now saved. The cost of electric power furnished for turning the table must be deducted from the saving above shown. According to figures obtained from the railroad company, the average power required to turn the table with one locomotive, is equivalent to one-half a horse-power hour. Assuming six pounds of coal per horse-power hour, and coal at $2 per ton, this would give a cost of 0.3 cent for fuel for turning one locomotive, or 53 cents per day for coal for the total number of engines turned.

Referring to the engravings, it will be seen that the device consists of a one-wheel cart, which is attached to one end of the table by means of a flexible spring connection, the cart running on the circular track in the table pit. The necessary traction is obtained by the weight on the driving wheel of this cart. This weight is about 3,000 pounds. The device requires no alterations whatever in the table or pit. The means for operating consists of a resistance or starting box, which may be set either on the platform over the cart or, as shown in the engraving, at the center of the table. This resistance box regulates the table so that it can be run in either direction by the movement of one handle either forward or back of the center. The electric connection from the power dynamo is obtained by means of wires which are brought overhead to a light arch at the center of the table, thence to the resistance box, and from the resistance box to the motor. The motor is of a "series-reversible" type of 10 horse-power capacity. It is entirely enclosed and waterproof ; in fact, the apparatus has been running exposed to the weather, as shown in the views, without the slightest injury. The motor is flexibly suspended on the cart, so that all shocks in starting or reversing are removed. The motor and apparatus were manufactured by the Gibbs Electric Company of Milwaukee.

The application is of special interest from the fact that it did not require any alteration of the table except the removal of the hand bars. Nearly all modern railroad shops include a lighting dynamo in their equipment, and this may also be used for power without interfering with the lights, but where it is expected that the former application will be extended it is advisable to install a specially adapted power plant. The apparatus under consideration operates under a voltage of 220, the current being produced by two 110-volt dynamos arranged in series. The compactness and simplicity of the design is worthy of note, and it is apparent that such an arrangement is admirably adapted to the purpose. We are indebted to Mr. J. N. Barr, Superintendent of Motive Power, and Mr. George Gibbs, Mechanical Engineer of the road, for the photographs and the information presented.

Caboose Car—Lake Shore & Michigan Southern Railway.

Through the courtesy of Mr. A. M. Waitt we give a description of some new caboose cars recently built by the Lake Shore & Michigan Railway from his designs and drawings. The car is 30 feet in length over end sills. The platforms are 30 inches

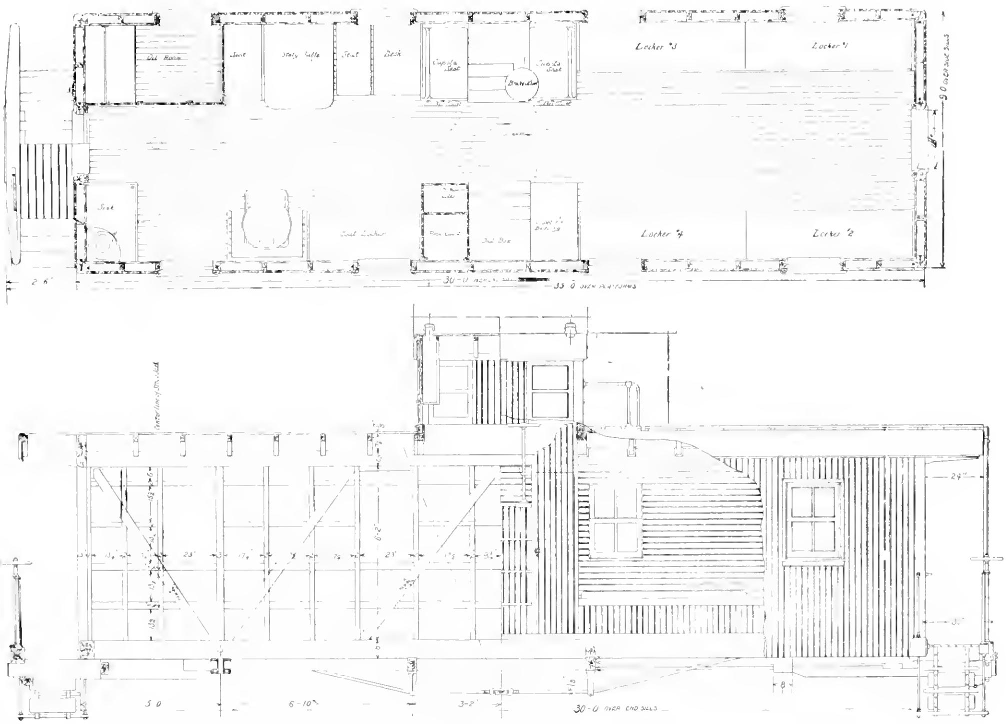


Caboose Car, L. S. & M. S. Railway.

wide, adding 5 feet to the length of the car. The width over side sills is 9 feet. The height from rail to top of cupola is 12 feet 9 inches. For the main-floor timbers the following sizes are used: 4½-inch by 8-inch center sills, 3½ inches by 8 inches for both intermediate and 5 inches by 8 inches for side sills. The end sills are of 6-inch by 8-inch oak and the needle beams of 4-inch by 6-inch

oak. Two 1¼-inch truss rods and two ⅞-inch counter truss rods are used. The body bolster is of iron, 8 inches wide, formed of ⅝-inch and ⅞-inch plates for top and bottom members respectively. The flooring is two courses of ⅞-inch pine, the lower course being laid diagonally and the upper one lengthwise of the car. The side framing is of the usual form, using both braces and brace rods. The arrangement of posts and braces is such as to give four good-sized windows on each side of the car. The roof, except at the cupola, is formed by long carlines extending from side to side; ⅞-inch roof-boards laid lengthwise are fastened to these and the roof is then covered with tin. Running boards extend along the car near the center. Sandwich carlines, formed timbers, form the platform sills. The platform is also supported by two ⅞-inch truss rods, extending up and through the body end sill and hooking over the upper member of the body bolster.

The trucks have a wheel base of 5 feet 6 inches. The framing of the timbers is similar to that of a passenger truck. The wheel pieces are of wood, 4½ inches by 8¼ inches in section. Near the center a truss of ⅝-inch by 2½-inch iron stiffens the timber and also helps to hold the transom lips in place. The end rails are 4½ inches by 5 inches, the one at the outer end of the car being cut down near the center to clear the draw gear. The transoms are of wood, 4½ inches by 10½ inches in section, each trussed with two ⅞-inch rods. The bolster is made of a single



Caboose Car, L. S. & M. S. Railway.—Designed by Mr. A. M. Waitt.

of two 1½-inch by 3-inch wooden pieces bolted to ⅜-inch by 2½-inch iron carlines, are used to stiffen the roof at the cupola.

The cupola is considerably changed from those on former Lake Shore caboose cars. In order to give more room inside and not to have much of the weight rest on the roof carlines, causing leaky roofs by sagging, the cupola was widened till the side sills rested directly on the side plates of the body. The end sills are deep and extend clear across the car, being directly above the sandwich carlines. The upper part of the framing of the cupola is narrowed, both for the sake of appearance and to give the necessary clearance. The cupola is tied to the body of the car by ⅝-inch bolts at each corner, extending from the plate of the cupola down through the side plate of the car body. It is also held by a number of strap bolts. Each side of the cupola has a sliding and a fixed window. The central part of the ends is utilized for signals and toward one side there is a window and on the other a door.

For the draft gear, the Lake Shore standard for freight cars, having a pocket coupler and double draft springs, was followed. The draft timbers extend back to the body bolster and are firmly bolted to the center sills. These, in connection with two more piece of wood, 8½ inches by 12 inches, and is also trussed with two ⅞-inch rods. Equalizing bars are not used. Helical springs are used over the journal boxes and elliptical springs under the bolsters. The truck has a total length of 9 feet 6 inches over end rails and a width of 6 feet 7¼ inches over wheel pieces, 3¾-inch by 7-inch axles, and 33-inch cast-iron wheels are used.

The cars are equipped with air-brakes. The brakes can be operated by hand from either end of the car and also from the cupola platform. For the latter purpose a chain is attached to the clevis of one of the hand brake rods; then passing around a pulley it is attached to a brake mast near the center of the car, the hand wheel being in the cupola.

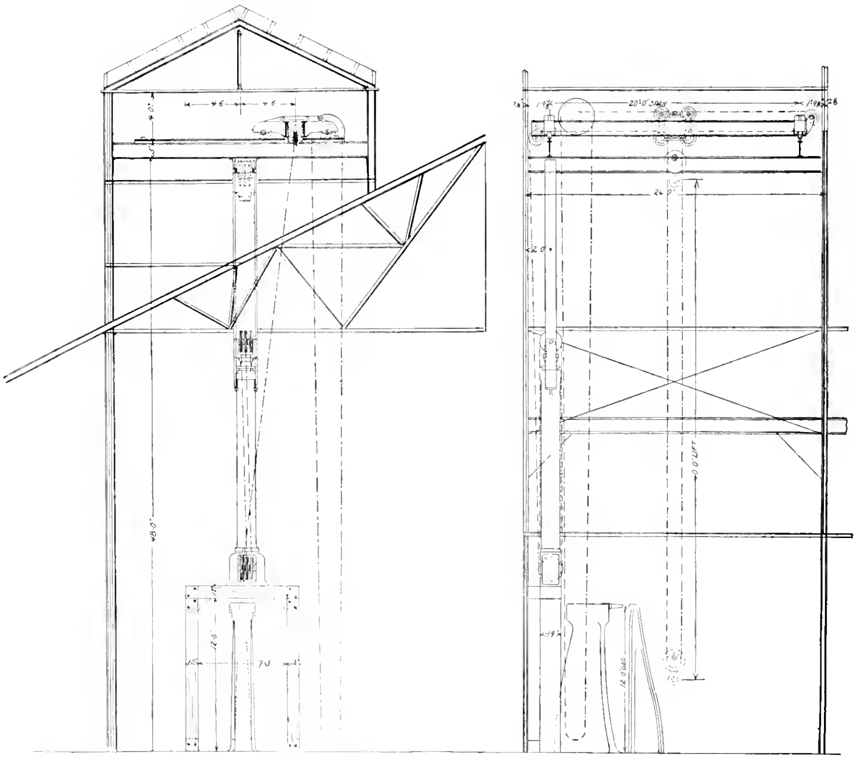
The interior of the car is divided by the partition at the cupola into three parts, the two end sections being connected by a passageway about 3 feet wide. In one end there are four lockers forming seats occupying the full length of the side walls. These contain the usual equipment of chains, rope, links and pins. In the other end on one side is the stove and coal locker, while in the corner is located the water cooler and sink. On the other side of the car a desk, table and two seats occupy the space from the cupola to the oil-room, which is in the corner. The interior

of the oil-room is fitted with drawers and shelves to accommodate the supplies.

At the center of the car, steps on each side lead up to the cupola platform. Beneath the platform are closets for clothes, bedding, tools and the train signal number plates. On account of the wide cupola all signal lamps are placed inside. At the center of the end of the cupola there is an inner and outer window sash. Between these two and on the face of the inner sash, plates of tin slide in grooves. These tin plates are cut similarly to stencil plates, with figures and letters. In the upper groove are put the train number plates and in the lower groove the plates giving the number of the section, if the train contains more than one. At night a light in the box just back of the sash shines through the stencil openings in the plates, making them easily visible. On both sides of this central window are the red lights. All the lights are enclosed in zinc-lined boxes and can be examined and attended from the inside of the car. Both ends of the cupola are alike in respect to arrangement of signals and lights. The caboose car complete weighs 34,000 pounds. The design is well worked out and the comfort and convenience of the train crews, as well as durability of construction, have been considered by the designer.

Hydraulic Riveting Plant—Chicago & North-Western Railway.

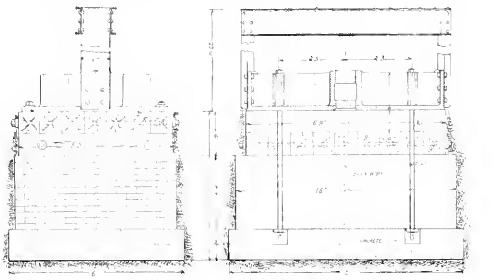
The use of higher pressures in locomotive boilers has forced the conclusion that the riveting of boiler joints must be attended to with the greatest care in order to prevent troubles which were not present with or at least not important in the earlier work with comparatively low pressures. The question of what power to use in riveting the shells of locomotive boilers has been solved by the leading locomotive-building firms in favor of hydraulic as against steam or air pressure, and the superiority of hydraulic riveting lies in the method of applying the pressure to the rivet. The work is best done by a steady pressure and not by a blow or sudden shock, and herein the hydraulic ram excels. It is also free from the rebound or recoil which must occur when an elastic fluid is employed to drive the plunger. Boilers riveted by hydraulic power have given much better records under high pressures than have been obtained by other methods. It is expensive to instal a special hydraulic plant in railroad shops for this work, but it will undoubtedly pay to do so, for what is good for high pressures must also show on the right side of the repair accounts for lower pressures. The Chicago & Northwestern Railway has recently installed one of the best hydraulic plants now in use on locomotive work in this country, and the fact is worthy of wide notice. The accompanying engravings illustrate the general arrangement of the machinery, and they are presented through the courtesy of Mr. Robert Quayle, Superintendent of Motive Power of the road. The plant was recently inspected by an officer of one of the prominent locomotive-building firms and the only criticism offered was in the form of a lament that the plant was not in his shops instead of in a railroad repair shop. This is enough to say to show that the design, arrangement and construction of the apparatus is satisfactory.

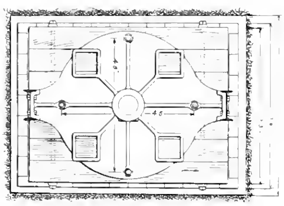


Tower and Hoist for Hydraulic Riveting Plant.

The specifications under which the machinery was built required a 12-foot gap in the riveter which was to work under a pressure of 1,500 pounds per square inch, and attachments were required which should give the operator control over the pressure upon the rivet, so that by the operation of a convenient valve he could obtain either 25, 50 or 75 tons' pressure as required for the

work in hand, and this without changing the accumulator pressure. The riveter is shown in the illustrations and its location with reference to the pumps, the accumulator and the hoist are indicated in the small plan. The plant is located in the end of the locomotive boiler shop, where an addition was built upon the end of the shop for the purpose. The tower shown in the engravings is of steel construction and was calculated for supporting the heaviest locomotive boilers. The tower crane has a lift of 35 feet and a span of 20 feet. It is located in the tower over the riveter, and is controlled from the level of the





Foundation for Accumulator.

work, and by the attendant who operates the riveter. The hoisting cylinder is mounted behind the riveter. The accumulator shown in the illustrations has a diameter of 18 inches and a stroke of 14 feet. It is mounted upon a substantial foundation. The crane is of the Morgan Engineering Works standard form and the riveter and accumulator are also of the design of this firm. The riveter is of cast steel in two parts, the main frame being a single casting, carrying the cylinder and valves, and the post is also a single casting, the two being secured by large bolts passing through lugs in the castings. The bearing of the post is ample. The top of the riveter is so designed as to leave no projection above the dies, which facilitates riveting the difficult places in a boiler.

The pumps are compound and of the duplex type specially constructed for this work. The two high-pressure steam cylinders are 12 inches in diameter, and the two low-pressure steam cylinders are 18½ inches in diameter. There are two pairs of 2¼-inch water plungers, the stroke of the pump being 10 inches. The capacity of the pump when running at a piston speed of 50 feet per minute is 20 gallons. The steam pressure is 80 pounds per square inch, and the pumps are capable of exerting a pressure of 2,000 pounds per square inch, although the working pressure is but 1,500 pounds. The steam cylinders are made of special close-grained iron of sufficient thickness to admit of reboring. The steam valves are plain slide valves, and the valve motion has outside adjustable tappets. The low-pressure cylinders have cushioning valves so that an even and constant stroke may be maintained. The water plungers are of the trombone pattern, the two plungers on each side being connected to crossheads, and the crossheads are connected by heavy wrought-iron side rods. The valves are above the plungers and are always submerged to avoid the necessity of priming the pumps. The general dimensions of the pumps appear in the engravings. They were built by the Deane Steam Pump Company, of Holyoke, Mass.

This plant was installed with a view of doing all of the boiler work of the road at the West Chicago shops, where the locomotives will be brought when they require new fireboxes or other extensive boiler repairs.

Resolutions on the Death of George Royal.

The committee appointed by the Western Railway Club to prepare resolutions on the death of Mr. George Royal, submitted the following:

WHEREAS, Mr. George Royal, an honored and highly esteemed member of this association, departed this life on the 5th day of February, 1897, and

WHEREAS, Mr. Royal being a man of the very highest principles, essentially a man of peace, of kindly disposition, a companionable man in the fullest sense of the term, one of unusual ability, and whose honored friendship was in an unusual degree esteemed by all of us who knew him or came in contact with him, and whose work for the good of humanity in the cause of his Master endeared him to hosts of people both within and outside the ranks of railroad service; be it

Resolved, That we feel with more than ordinary sorrow the removal of such a life from our midst, and that his sterling qualities of character and disposition, and his championship of the cause of peace and good will between man and man will always be held in grateful remembrance;

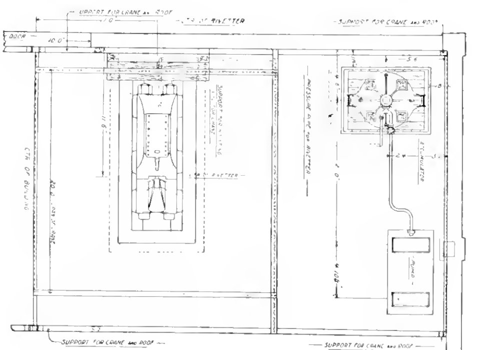
Resolved, That with deep sympathy for the bereaved relatives of our friend, we exprese a hope that even so great a loss to us may be overruled for good by Him who doeth all things well;

Resolved, That a copy of these resolutions be spread upon the records of this club and a copy forwarded to the bereaved family.

Committee { R. QUAYLE, F. W. FURRY, W. O. THOMPSON.

Lake Shore Annual Report.

The report of the Lake Shore & Michigan Southern Railway Company for the year ended Dec. 31 last shows a decrease in freight earnings over those of the previous year of 6.13 per cent., an increase in earnings of 0.17 per cent., and an increase in earnings



Plan of Hydraulic Plant.

from mails, express, etc., of 1.65 per cent. The number of tons of freight moved was 13,662,419, a decrease of 5.01 per cent., and the average rate per ton per mile was 0.5487 cent against 0.5615 cent for 1895, a decrease of 0.0128 cent, or 2.28 per cent.

The number of passengers carried was 4,519,887, a decrease of 107,288, and the average rate per passenger per mile was 2.141 cents, against 2.139 cents for the previous year, an increase of 0.002 cent, or 0.09 per cent There was an increase in freight traffic earnings from January to April of 7.78 per cent., but a falling off in the rest of the year. The ton mileage decreased 3.99 per cent., but the mileage of freight trains decreased 4.91 per cent. The average load of freight trains was again increased; in 1895 it was 318.5 tons, and last year it was 321.6 tons. The operating expenses, including all taxes and betterments, were 67.97 per cent., against 69.32 per cent. the previous year. Operating expenses included the following expenditures: New equipment, $816,302; changes of grades, $95,443, and new sidetracks, $30,780, a total of $942,525.

Elasticity and Fatigue.

H. K. LANDIS, E. M.

PART II.—FATIGUE.

We have discussed the factors which make the elasticity of steel such a complicated subject. We have acknowledged that steel cannot act like an isotropic body, and therefore that its comparative elasticity is a variable quantity depending on factors which are not generally investigated. We have also seen that the determination and evaluation of elasticity is a process which gives very approximate results. We will now examine into the relation between elasticity and fatigue, and endeavor to show how important it is that we should know the true elastic condition of a steel before we can calculate the amount of service which it will withstand. We must first divest our minds of a few antiquated cob-webs. There is no such thing as fibrous or crystalline iron or steel as far as structure is concerned, although the fractured surfaces may have such an appearance; toughness is not an exclusive property of iron or steel which is low in carbon, for there are other factors which are much more influential than carbon; endurance cannot be gaged by the closeness of the unit load to the elastic limit as determined by drop of beam; the fractured surface of a member broken through fatigue is not always crystalline, for this appearance depends very largely upon the initial condition of the metal and method of fracturing.

Fatigue.—The generally understood meaning of this term is the weakening of the material due to stresses repeatedly applied. The word was defined by Braithwaite about 1854 as the "progressive destructive action arising from repeated loading," and the first use of the term is attributed by him to Field. The first experiments of value were conducted by Wöhler between 1859 and 1870 under the direction of the Prussian government. As a conclusion deduced from this work he stated that rupture may be caused by oft-repeated stresses below the ultimate resistance of the material, the number of vibrations necessary being inversely proportional to their greatest value and also to their difference. He was followed by Bauschieger (see his *Mittheilung* xv., 1886), Spangenberg, Fairbairn, Hodgkinson, the U. S. Testing Laboratory and many others whose experiments extend up to the present time. The first experiments were efforts at making the test represent actual service as nearly as possible, which tendency was well expressed by Sandberg when he said: "I have always held that in testing an article the *modus operandi* should, if possible, be adapted to the functions it has to perform in practice." Consequently much of the early work was on full-size specimens, but as the conditions were hard to duplicate the results were not exactly comparable, so that the later tests are made on rotating bars about a yard long and an inch in diameter.

Repeated Stresses.—One of these early experiments made by Kohns was to determine the effect of small torsional stresses on iron bars, the bars being broken afterward under a press to ascertain the kind of fracture and angle of bend; this fracture was found to become gradually more crystalline until at the end of a year, after receiving 100,000,000 torsions, it had the appearance of the fracture surface of cast zinc. Schrotter concludes from these tests that: 1. Repeated torsions can change fracture from fibrous to crystalline, the strength decreasing. 2. The number of torsions necessary depends upon their magnitude. 3. Impacts increase the effect of torsion, or without torsion produce ultimately the same structural changes. 4. The changes are due to mechanical action—not to temperature. These conclusions agree well with later investigations.

Alternate Stresses.—In 1888 the United States Ordnance Department, at the Watertown Arsenal, began a series of tests on the endurance of metals. Bars one inch in diameter and 33 inches between horizontal swivel supports were loaded by weights hung from a friction wheel trolley, resting, with its two pairs of wheels 4 inches apart, at the middle of the bar; the latter was rotated at about 400 revolutions a minute by means of a lathe-head attached at one end, and the trolley pan was loaded with weights until the bar bent far enough to indicate the required unit stress on the outside fiber, called the fiber stress. What seems to the writer a better device is that devised by Sondericker (see Technology Quarterly, Boston, Mass., 1892, p. 70). It differs from the preceding in having the load supported from two points which divide the bar into equal thirds and make it assume an approximately uniformly stressed curve instead of having a maximum stress at the middle. Deflection is measured by the divergence of two arms fastened between the friction load bearings. The load is applied through two horizontal straight springs linked at the ends and loaded from the middle by means of a scale beam. When the desired deflection is obtained the lower spring is clamped and the rotations begun. Some of the results are presented, as they show interesting relations to elastic limits. Howard thinks on good authority that endurance is a function of tensile strength and not of elasticity; he determines the elastic limit as the first appreciable permanent set. The ratio of elastic limit (E. L.) to tensile strength (T. S.), according to his reports, varies from 60 to 90 per cent., so we conclude that this point was found to be a very elusive factor, and as full of "ways that are dark and tricks that are vain" as Bret Harte's Chinaman. We therefore substitute instead of F. S. ÷ E. L. the ratio of stress to strength, calling the maximum tension on the outside fiber of the rod, F. S.

RELATION OF STRESS, STRENGTH AND ENDURANCE OF MILD STEEL.

F. S.	F. S. / T. S.	Total number of revolutions required for fracture.	Authority and T. S.
24,000 to 32,000	.35 to .47	41,457,000	Sonderleker. Cold-rolled steel. " (T. S.=81,700)
36,000	.53	2,849,000	" (T. S.=68,100)
36,000	.53	1,271,000	" "
26,000	.42	14,876,432	Baker.
34,000	.55	155,295	" (T. S.=62,000)
36,000	.58	60,200	" "
35,000	.56	763,400	Watertown arsenal.
40,000	.64	310,100	" (T. S.=62,000)
45,000	.73	90,300	" "
50,000	.80	49,875	" "
45,000	.73	70,750	" "
48,000	.77	55,900	" "
53,000	.85	23,100	" "
52,460	.85	14 800	" "

In the accompanying table, the relation between the loads successively applied and the ultimate strength, with the fatigue of the shaft thus stressed, is clearly shown. The numbers have been selected so as to secure the approximately average relation. Each revolution produces a tensile and a compressive stress on any outside fiber equal to F. S. The tests of Baker (Trans. Am. Soc. Mech. Eng., Vol. IX., 1887, p. 160) were made by fixing a shaft 1 inch diameter and 10 inches long into the end of a rotating shaft, and deflecting the other end into a bearing so far that the required unit stress was secured at the bent portion, tension and compression alternating as with the others quoted, while the shaft revolved 50 to 60 times per minute. For a steel of the quality referred to, Mr. Henning has said that the limit of proportional elasticity lies at about 54 per cent. of the tensile strength. If we examine the second column, we will notice that those stresses lying below 0.54 are comparatively small in their effect on endurance, while those above 0.54 withstand but few revolutions. The elastic limits given by tests range from 0.60 to 0.85 of the tensile strength, although the numbers in the third column indicate that elasticity has been passed through long before that point was reached. In each of these tests the bars were rotated until broken. The fact that elastic limits are not the only factors which control safe working loads is determined by observing that different material breaks at one-half or one-third its breaking tensile strength. And we naturally turn for the explanation to the same influences which destroy elasticity.

Cold Working.—It is a known fact that when steel is compressed until it takes a permanent set—i. e., does not quite return to its original length, and is then subjected to tension, that it has no definite elastic limit, but it begins to take small sets from the the beginning of tension. Cold rolling or cold drawing has much the same effect—i. e., the steel is no longer proportionally elastic for any stress; therefore we would expect progressive breaking down from the beginning, and this is what happens. Sondericker

could find no elastic changes in cold-rolled steel; he likens the effect of repeated stresses to that of cold rolling—i. e., hot-rolled bars, when rotated, gradually stiffen and have their T. S. and E. L. (first permanent set, yield-point) raised, which is shown by their decreased deflection under the constant load. Cold working also increases strength remarkably, but this does not prove its ability to resist fatigue. Watertown Arsenal tests show that when the fiber stress causes a permanent set the deflections are diminished and the temperature rises. The highest T. S. is at about 400–600° Fahr., though the elastic limit decreases. At these higher temperatures shafts endured four to ten times as many rotations as duplicates at ordinary temperatures; it was further determined that the deflection of the middle of the shaft under load was not affected by the speed of rotation. To show the comparative effect of hot and cold rolling on endurance the following test is given as representing deductions from many others. The end specimen gives about the initial strength, while the middle one was cored out till but $\frac{1}{16}$ inch thick to show the effects of alternate stresses.

	Hot-rolled mild steel.	Cold-rolled iron.
F. S., pounds pere square inch	40,000	45,000
Number revolutions	87,900	80,000
T. S., pounds per square inch, middle	67,070	57,720
" " " " " end of bar	61,000	71,960
Ratio of F. S. to T. S. at end	0.66	0.63
Difference T. S. at end and middle	+ 6,070	— 14,240

Duplicate specimens broke at about twice the above number of revolutions under the same conditions. The test shows clearly the fact that cold-rolled iron loses strength from the first, while hot rolled gains in strength until a permanent set forms.

Other Influences.—Sondericker concluded from his experiments that "the elastic limit (yield point) does not appear to be a sufficient criterion for judging of the capacity of material to resist repeated stresses," and conceived the causes of failure to be local, the material as a whole suffering no deterioration. In the specimens tested he traced the cause of failure to bruises on the bar, shoulders, flaws, etc., acknowledging, however, that "fracture results from molecular changes produced by repeated stress, extending through the entire mass," thus causing progressive weakening, such fatigue starting from a point of weakness and there developing as a local maximum.

It is well known that annealed steel will withstand a greater number of stresses than either untreated or hardened steel when the ratio of F. S. to T. S. is the same. Annealing removes residual stresses, and permits the metallic particles to adjust themselves to a condition of closest contact, consequently giving greatest uniformity, which is one of the requisites of isotropy and perfect elasticity. Internal stresses occur in all cold or hot forged material which has not been annealed. Sometimes they are in magnitude nearly equal to the elastic limit, and are usually from 1,000 to 5,000 pounds per square inch.

Briefly, we can explain the effects of fatigue by saying that the particles of steel kept in movement tend to accommodate themselves to paths which lie in the line of their least resistance to motion; these paths sometimes become planes, so that when fracture occurs through stock, inertia may assist in cleaving by aid of these planes. They, however, need not be planes of weakness, for a slow pull may stretch the particles, just as iron filings hang from a magnet by their own polarity, and cause a fibrous appearance. A crystalline surface of fracture does not always exist in fatigued steel, even when broken by shock, for we must remember that many of the failures attributed to fatigue pure and simple are due more immediately to some local imperfection, some condition of abnormal stress or local segregation, some local incipient deformation caused by careless handling, or other cause, which is no fault of the material itself, but rather of its condition. Given a normal steel, free from mechanical imperfections, we can calculate with much certainty the amount of work it will withstand, for such material will transmit and resist stress equally in all directions while it remains elastic. From this we conclude that as far as fatigue is concerned, elasticity is the principal consideration.

It is not supposed that members shall be subject to a permanent set in ordinary service; therefore the work of fatigue lies within the limits of resistance usually termed elastic. The trouble lies in the determination of the elastic limits, as we have noted before, for as they are reported almost invariably too high, it follows that the allowable working stress will be placed too high and the material will break from cumulating sets long before it is expected to do so.

Prevention or removal of fatigue will necessarily depend largely on the mechanical condition of the metal. In general, we may recommend annealing before using to remove the effects of fatigue or to remove internal stresses. Strength may be obtained by heating to a salmon color, 1,500 to 1,600 degrees Fahr., quenching in oil and then annealing at a full red heat, or about 1,100 degrees Fahr. Rolled or cast sections should be designed so as to avoid large masses of section adjacent to their webs or parts that will cool more quickly and thus cause initial internal stress. It is probable that all steels will ultimately fail by fatigue, no matter what the unit stress, but experiment tells us that stresses below the limit of proportionality are very much less destructive.

A French Engineer on American Locomotive Practice.

The papers by Prof. W. F. M. Goss, of Purdue University, entitled "Notes on the Performance of the Purdue Locomotive, Schenectady," read before the Western Railway Club in May, 1896, and "Effect of High Rates of Combustion on the Efficiency of Locomotive Boilers," read before the New York Railroad Club in September, 1896,* have attracted considerable attention abroad, and in reprinting the papers the Revue Générale des Chemins de Fer publishes introductory comments upon them by M. Solomon, Chief Engineer of Motive Power and Rolling Stock of the Eastern Railway of France, from which the following abstract has been translated:

It is only very lately that American engineers have paid any attention to the study of the coal consumption in locomotives and to the possibility and opportunity of practising economy in that line of expense which they estimate to equal 30.7 per cent. of the total cost of traction. If they have so long delayed studying that important question, they are, at least, doing it now with that activity peculiar to their race. The engineering societies of America as well as the technical press are discussing warmly the propriety of keeping records of the amount of fuel consumed by locomotives; of adopting schemes which will serve as an incentive to economy among railroad employees; and of studying composition of fuels and the processes of combustion, etc., important questions which have been solved in France a long time ago. If the superintendents of motive power of the United States are, like their colleagues of the permanent way and track departments, moved by the necessity of reducing the excessive expenses in the working of their railway systems, they have, moreover, technical motives which prompt them to search and to determine the various causes which give rise to the excessive coal consumption in their locomotives.

The weight and velocity of trains have increased with the development of traffic, but the motive power has not been improved in proportion. The weight of a passenger train reaches 500 tons; that of a freight train 1,000 tons and sometimes more. The necessity of causing locomotives provided with wheels of small diameter (48 inches for freight train locomotives and from 60 inches to 68 inches for passenger train locomotives) of the old American type to run at increased speeds has resulted not only in damaging the track and breaking rails by the action of the counterbalance, but also in causing a startling increase in coal consumption.

Thirty years ago the typical locomotive of the United States weighed about 27 tons, and its boiler was provided with a grate area of 15 square feet and an area of heating surface of 800 square feet. In the locomotive of recent make, the weight, the grate area and the heating surface are twice as great and they are required to produce four times more steam, because the trains have been doubled in weight and their speed has been increased at least 50 per cent. In short, the new locomotives must make twice as much steam per unit of heating surface and of grate area as the old ones. In heavy services, thanks to a strong draft which equals 12 and sometimes 16 inches, the coal consumption reaches and sometimes surpasses 190 pounds per square foot of grate area, a result which can be obtained only by the help of a strong blast action.

Having practically recognized that, in an overworked engine, the coal consumption increases much more rapidly than the energy which is made available for moving the train; that a considerable loss results from the insufficiency of the heating surface

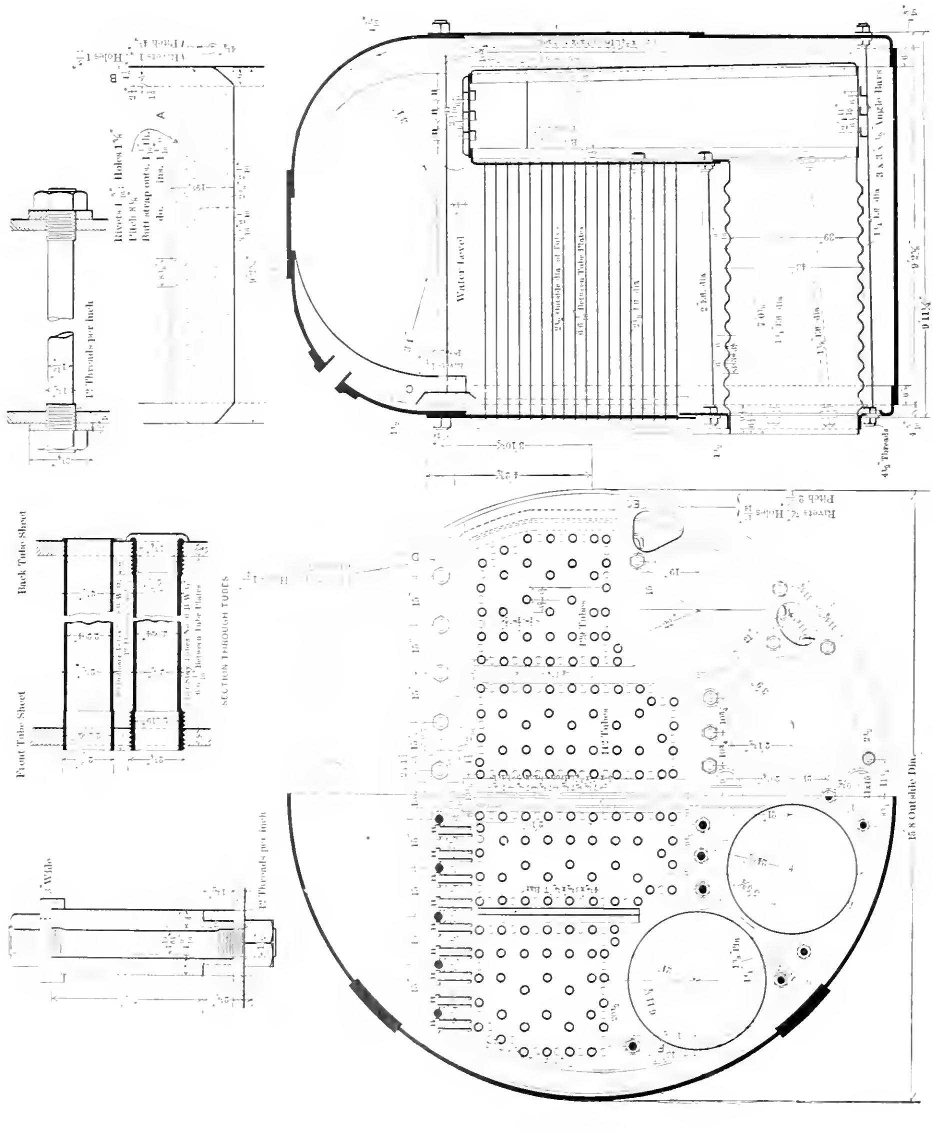
* For abstract of the latter paper see October, 1896, issue of AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL, page 254.

and grate area, it is evident that the American engineers have tried to account for this loss and to trace it to its various sources. They have endeavored particularly to determine the influence of small diameters of the wheels which necessitates an excessive speed of rotation, and also the influence of the small grate area and the limited amount of heating surfaces. In order to study these questions, Professor Goss has availed himself of the equipment of Purdue University. He has summed up the results of his researches into two papers read before railway clubs, the first one before the Western Railway Club in May, the second before the New York Railroad Club in September, 1896. On account of their importance, these papers have been reproduced, discussed and praised by the American technical press; this also led us to give their translation to the Revue Générale des Chemins de Fer.

Professor Goss by means of his experimental enclosed plant has been able to maintain the working of the engine under conditions which remain practically constant during several consecutive hours, causing to vary only the elements of which he was searching the influence. This would have been almost impossible to realize in experiments in ordinary service, which are continually disturbed by atmospheric variations and configuratio of the track.

In the paper of the first date Professor Goss studies the influences of rate of rotation on the efficiency of the locomotive as a motor. We regret that he has not given all of the conditions of the distributing arrangement, the angular advance, length of eccentric rod, return levers, etc., the absolute value of compression and of draft. We equally regret that Professor Goss has not tried to determine the ratio of diminution of work indicated on respective pistons caused by the increase of back pressure. Notwithstanding these omissions, Professor Goss' paper constitutes an extremely interesting contribution.

The second paper treats of the effects of high rates of combustion on the performance of locomotive boilers. It is more limited and at the same time more complete. In this paper Professor Goss gives no results relative to rates of combustion under 65 pounds per square foot of grate area per hour. This has been criticised by his countrymen, and is much to be regretted by European engineers whose locomotives rarely burn more than 65 pounds of coal per square foot of grate area per hour.



BOILERS FOR BATTLESHIPS NOS. 7, 8 AND 9, UNITED STATES NAVY.

In previous experiments not given in this paper Professor Goss has determined the decrease of vaporization per pound of coal, when the rate of combustion had been raised, *every part of grate surface being utilized.* We believe that the loss of vaporization must be attributed to the insufficiency of heating surface. In these experiments Professor Goss has used large soft coal, gaseous and flaming, very inferior for vaporization to the soft coal of Cardiff and Charleroi, and even to the fine soft coal of Lens and Courriere (*Pas de Calais*). We must not lose sight of this inferiority in comparing the results brought forth by Professor Goss with those of the many experiments made last year in France and England.

Boilers for Battleships Nos. 7, 8 and 9.

Of all the matters pertaining to improvement in steam practice the most interesting at this time are the designs of boilers. The boilers under consideration are not widely different from those used in some of the earlier ships, but they are probably to be considered as the design which the Navy Department will use whenever possible as a standard. These boilers are to be placed athwartships in the vessels, which is a departure in the practice of the department, and the curved form given to the ends greatly facilitates the disposition of the up-takes without causing them to occupy room which is greatly needed at this part of the ship. As shown in the accompanying engraving, the ends are curved to a radius of 3 feet 4 inches. Another advantage of the curving lies in the ease with which the tops of the boilers may be stayed. There are four 39-inch corrugated furnaces in each boiler, each being connected to the combustion chamber at the rear. There are two combustion chambers for each boiler, so arranged that one will be used for each wing. They are of $\frac{9}{16}$-inch plates, except the tube sheets, which are $\frac{3}{4}$ inch thick at the combustion chamber ends of the tubes. The top plates of these chambers are stayed, as shown, by girders, the dimensions of which are given in the detail drawing. The staybolts for these sheets are $1\frac{19}{64}$ inch in diameter, with nuts on both ends. The tubes are of iron and $2\frac{1}{2}$ inches outside diameter, and there are 542 for each boiler, the distance between tube plates being 6 feet $6\frac{1}{16}$ inches. The stay tubes are of No. 6 B. W. G. in thickness, and are reinforced at both ends to a diameter of $2\frac{5}{8}$ inches. There are 154 of these tubes in each boiler. They are swelled to $2\frac{3}{4}$ inches in diameter at the front ends, as shown in the detail view. The threads are parallel at the combustion chamber ends, the threads at the front ends being tapered to fit the tube sheets. The front joints are screwed tight and the back ends are made tight by expanding and heading. The back ends are protected by cast-iron ferrules of $1\frac{5}{8}$ inches internal diameter. The horizontal tube spacing is $3\frac{5}{8}$ inches, and the vertical spacing is $3\frac{1}{2}$ inches. The holes in the combustion chamber for the screw stays are drilled and tapped with the plates in place. The screw stays are screwed into both plates and are fitted with nuts on both ends, the nuts being set upon beveled washers, where the stays do not come square with the sheets. The upper longitudinal stays are riveted over the nuts when the nuts are screwed home. The staying of the bottom plates of the combustion chambers is in the form of 3 by 3 by $\frac{1}{2}$-inch angles.

The boiler material is open-hearth steel, and the usual tests of the department are specified. The shells are composed of one course of four $1\frac{7}{16}$-inch plates. The heads are flanged outwardly at the furnaces and inwardly at the circumference. The staying of the heads consists in the use of stiffening angles and doubling plates. The outside diameter of the boiler is 15 feet 8 inches, and each has a grate surface of 85.6 square feet, and a heating surface of 2,650.65 square feet, which is a ratio of 30.96 to 1 between the heating and grate areas. There are eight boilers of the single ended type for main steam purposes. The working pressure is 180 pounds per square inch. The drawing shows the dimensions of one of the riveted joints of the boilers and the strengths of the different joints with reference to the strength of the solid plate and of the rivets may be seen from the following table, in which the reference letters indicate the locations of the joints in the boiler, the corresponding letters being placed upon the joints shown in the views of the boiler in the illustration.

	Strength of Joint.	
	Per cent. of plate.	Per cent. of rivets.
A	83.58	84.68
B	69.12	71.83
C	62.06	62.70
D	76.25	78.5
E	68.08	52.98
F	60.52	43.80

The longitudinal joints of the shell are butted with $1\frac{1}{16}$-inch covering strips outside and inside, and are treble riveted. The joints of the heads with the shell are double riveted, except in the case of the upper curved plates, which are treble riveted. The furnace and combustion chamber joints are single riveted. All rivets are of steel and all rivet holes were required to be drilled with the sheets in place, and the rivets all to be driven by hydraulic power where possible. Where hydraulic riveting could not be used the rivet holes were required to be coned and conical rivets used.

The grate bars are of cast iron and the bars at the sides of the furnaces are made to fit the corrugations. The tubes of the boilers are arranged in vertical rows, and circulating plates are provided at each side of each nest of tubes. These are of $\frac{1}{4}$-inch steel made in sections so as to be easily taken out through the manholes. They are supported by the stay tubes. For convenience the chief dimensions of the main boilers are given in the following table:

Dimensions.	One boiler.	Eight boilers.
Length of fire bars	6 ft. 7 in.	6 ft. 7 in.
Area of fire grate	85.6 sq. ft.	684.8 sq. ft.
External diameter of tubes	$2\frac{1}{2}$ in.	$2\frac{1}{2}$ in
Length of tubes between plates	6 ft. $6\frac{1}{16}$ in.	6 ft. $6\frac{1}{16}$ in.
Number of tubes	542	4,336
Surface of tubes	2,307.65 sq. ft.	18,461.2 sq. ft.
" " furnaces	155 sq. ft.	1,240 sq. ft.
" " combustion chambers.	188 sq. ft.	1,504 sq. ft.
Total heating surface	2,650.65 sq. ft.	21,205.2 sq. ft.
H. S. ÷ G. A	30.96 : 1	30.96 : 1
Pressure per square inch	180 lbs.	180 lbs.
Steam space, cubic feet	358	2,861
Combustion chambers, cubic feet	197	1,576

The engines to be supplied with steam are in duplicate, driving twin screws, and indicate 10,000 horse power with cylinders $33\frac{1}{2}$, 51 and 78 inches in diameter with 48 inches stroke.

These battleships are being built by the Union Iron Works, the Newport News Shipbuilding and Dry Dock Company and the Cramps, each concern building one ship. These boilers were designed by the Bureau of Steam Engineering for these ships, but it is understood that a slight modification is permitted in the ship which the Cramps are building.

Break-in-Twos and Air Brakes.

Since the subject of break-in-twos in trains between cars equipped with M. C. B. couplers was so spiritedly discussed at the 1896 convention of the Master Car Builders' Association, many members have been thoughtfully considering the matter with a view of reducing such numbers of cases of this form of accident as was reported by Mr. Waitt in that discussion. It will be remembered that Mr. Waitt stated that in the first five months of 1896 he had records showing 467 cases of break-in-twos in trains either in the yards or on the road. This was thought to be a large number, but the fact was developed that it was not an unusual record, many other roads having had somewhat the same experience. Mr. G. W. Rhodes has put some of the results of his attention to this matter into a paper entitled "Air Brakes, why Important to Maintain Them," recently read before the St. Louis Railway Club, in which he treats of the influence of the air brakes in this trouble and says:

Now that air brakes are being so generally applied to freight cars and will soon be required by law, railroad men cannot be too particular in providing proper facilities for inspecting and maintaining them. When a railroad has one-third of its freight cars equipped, we believe the proper maintenance of such brakes is more important than buying new brakes for the remaining two-thirds of the equipment. If our air brakes are not up to the M. C. B. standard, or, are not maintained so that they will work in accordance with that standard, constant trouble on the road through break-in-twos and derailments will result. Already the growing frequency of break-in-twos in freight train service is attracting the attention of operating officers: the principal offender, named, but not convicted so far, appears to be the M. C. B. coupler. We believe neglected air brakes are as much to blame. A spirited discussion on the subject of break-in-twos in freight train service will be found on pages 68 to 77 of the 1896 M. C. B. Annual Report. At the brake tests in 1886 and 1887 there were many break-in-twos, but no one thought

of blaming the couplers. The shocks produced by the tardiness of the brakes was what was blamed. Here, then, is a fine opportunity for co-operation between the operating officer and the shop man. Let each operating officer insist that his trainmen shall apply the M. C. B. air brake defect card, one on each side of every car that passes over his division with the air brakes out of order. These cards will at once become a tell-tale as to the condition of the air brakes. I have here a number of cards that have been removed from cars after the repairs have been made. Their usefulness is so apparent they need no description, and yet I know of important trunk lines that do not use them. They are fully described on page 496 of the 1896 M. C. B. Annual Report in the list of recommended practices.

Let the operating officer at once see what provision is made for the care of air brakes on his division. If any of the yards and shops are not suitably provided for testing and reparing brakes, I feel sure that the cost and delays incident to break-in-twos will so overshadow the expense of appliances for properly caring for the brakes that there is no operating officer but will co-operate with the shop officer in the heartiest way until the desired appliances are secured.

In conclusion, the principal reason why air-brakes should be maintained is to avoid the disastrous break-in-twos and shocks experienced during the Burlington brake trials, and which now seem to be slowly creeping into everyday freight service. As a remedy we offer the following recommendations:

First—See that freight air brakes meet the M. C. B. standard requirements.

Second—See that railroad shops and yards have facilities for maintaining brakes.

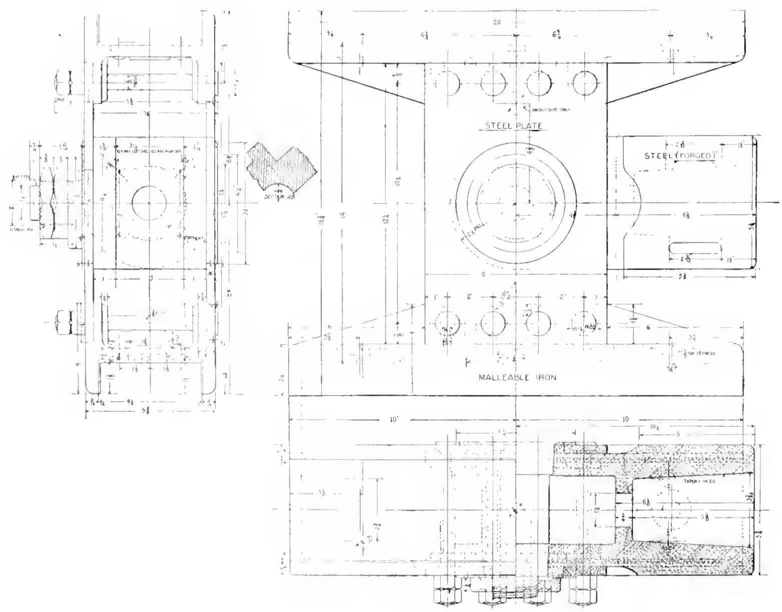
Third—Encourage trainmen to use the M. C. B. air brake defect card.

Fourth—Maintain a force sufficient to keep air brakes in proper order.

It is believed that with these precautions carried out, break-in-twos with their attending delays and expenses will disappear as quickly as they did at Burlington 10 years ago, when, on account of tardiness of application, tests of power brakes of all kinds were abandoned, excepting such as had their brake valves actuated by electricity, which has since been supplanted by quick action brakes.

An Articulated Crosshead.

The design of an articulated, locomotive crosshead which is being experimented with on the Norfolk & Western Railway is shown in the accompanying engraving, which was prepared from a drawing received through the courtesy of Mr. R. H. Soule, Superintendent of Motive Power of that road. The general arrangement of the parts of the crosshead may be seen in the illustration. The shoes or slippers are separate castings of malleable iron connected by two ⅞ by 8 by 12¼ inch steel plates. These plates are bored to receive a forged steel head which forms the piston rod fit and also provides the bearing for the wrist pin. This head is free to move about the pin and is pivoted in the holes in the side plates and herein consists the articulation. This design was made with a view of preventing the breaking of piston rods close to the crosshead fit owing to the transverse strain of the overhanging weight of the piston on the end of the rod when the crosshead is a neat fit in the guides. This method of construction allows the piston rod connection to adjust itself so as to relieve the rod itself of transverse strain. The crosshead is giving satisfaction and appears to fulfill the expectations of the designer. The dimensions of the bearing surfaces are given in the engraving. While no great effort appears to have been made to secure lightness the construction admits of keeping the weight down to satisfactory figures.



An Articulated Crosshead—Norfolk and Western Railway.

What Engineers Lack.

In a paper read before the Boston Society of Civil Engineers Prof. George F. Swain treated of the present status of the engineer, and the following paragraphs are selected as being specially worthy of consideration:

To my mind, the principal defect among engineers to-day is a lack of breadth and culture. Engineering, in its highest sense, is no doubt a learned profession, but it is too apt to be a narrow one. In many of its branches it should, if properly practised, require as great learning and as firm a mastery of scientific principles as any other profession. But there is, to my mind, no doubt that the engineer does not occupy as high a position in modern life as do members of the professons of law, medicine or theology, and I believe it is mainly on account of this defect. The engineer is too often looked upon as a skilled artisan, as one who works with actual materials, but without the aid of art, and sometimes without the aid of science. There, are, of course, many exceptions, but I believe that engineers to-day have, as a rule, less breadth of education and sympathy, are narrower and less cultured than members of these other professions. How many engineers are well acquainted with literature or history, art or music? I repeat, there are exceptions, but they only prove the rule. Engineers associate too exclusively with men of their own profession and not enough with leading men of other callings. This will be noticed if you examine the

list of members of any important club. I have one in mind in this city, composed of scientific and literary men and artists, in which, out of a total number of 496, only 11 are engineers, while over 80 are doctors and as many are lawyers. In another prominent club in this city, which has a membership of 550, only eight are engineers. In the Institute of Technology, with 1,196 students, 80 are college graduates, or 6.7 per cent. In the Harvard Medical School, of 454 students, 163 are college graduates, or 36 per cent. In the Harvard Law School, of 404 students, 305 are college graduates, or 75 per cent. These figures lend additional proof to the statements made above.

From an experience of many years in teaching, I can testify to the difficulty of making students in engineering schools appreciate the importance of any studies not purely technical in character. Filled with the enthusiasm for the profession that they are about to enter, they wish to devote themselves entirely to it, and it is only after they have neglected the opportunity to broaden themselves that they realize the loss, if, indeed, they realize it at all. And let me also express my conviction that any young man who has in him the elements of success will be a better and broader engineer, as well as a better citizen, 10 or 20 years after graduating, for having devoted some considerable time during his school days to general literary or economic studies. Parents who are not engineers generally, I think, desire to have their sons receive a broad training, and they are unable, of course, to appreciate the detail of the various courses presented in technical schools. If their son gets a course in stereotomy, they do not know or care whether it includes a very large amount of time devoted to the skew arch or not. Practising engineers, however, and students who do not know what they ought to have, but wish to devote themselves purely to engineering, and take no interest in anything else, are, I believe, almost always attracted by the large amount of time given in a purely technical course to the details of professional practice, and our schools are striving among themselves to see which can carry its undergraduate technical instruction to the highest point, no matter how narrow may be the graduate turned out. I am not arguing that a technical school should not endeavor to carry its instruction to the highest point, but I insist that the proper place for many advanced technical studies is not in the regular undergraduate course, but in a post-graduate course. Every student who graduates from a technical school should, in my opinion, have had a fair amount of training in general studies. Students who desire to pursue advanced technical courses, or college graduates coming to such a school, who have already completed the general studies, should find post-graduate courses ready for them.

I do not wish to be understood as definitely advising a young man who wishes to become an engineer to take a college course before going to a technical school. I simply wish to insist that he should in some way gain a breadth of training outside of his technical studies. One way is to take a college course first; another is to go to a technical school where the course is broad, and where, if he has the time, he may spend five or more years, instead of the usual four. To discuss the relative advantages of these two plans would lead me too far, and is not necessary in the present connection.

The Transmission of Power by Compressed Air.

There have been from time to time a number of papers presented to the Engineers' Society of Pennsylvania giving estimates of the cost of transmitting power in Pittsburgh by electricity, water, gas, etc. At the April, 1897, meeting Mr. Richard Hirsch read a paper on transmission of power by compressed air in which he gave the estimated cost of power furnished by a plant capable of transmitting 1,100 indicated horse-power. The first cost of the plant was placed at $275,000, including mains, etc., and the total annual cost of operation given as $60,000. For a total of 4,452,000 horse-power hours per annum the cost per horse-power per year of 3,000 hours is $40.50. To compare this cost with the cost by other means the author extracts the following from the past proceedings of the society:

Amount per horse-power per annum paid to the city of Pittsburgh for operating hydraulic elevators (about)	$700.00
Cost of power per horse-power per annum in a large store having its own plant, 15-hour service	128.44
Cost in same plant corrected for 10-hour service	89.92
Estimated cost per horse-power per annum at which power could be furnished by a proposed hydraulic power company, with no allowance made in operating expenses, for taxes or deterioration of plant	77.70
Cost in same plant corrected for above omissions	100 20
Estimated cost per horse-power per annum at which power could be furnished by an electric power company capable of delivering 20,000 horse-power	50.00

The efficiency of the compressed air system from the steam cylinders of the compressors to the brake horse-power of the motors is given as over 50 per cent, the air not being re-heated.

Electric Lighting of Cars from the Axles.

The advantages possessed by the electric light for the purpose of illuminating railroad cars have led to numerous experiments in the effort to secure a satisfactory system which should be cheap in cost of installation, operation and maintenance and yet be satisfactory and reliable in other respects. The American Railway Electric Light Company has for about three years been experimenting in the direction of obtaining light from a dynamo driven by the axle of the car and the apparatus is now complete and ready for the market, having entirely passed the experimental stage. The most important feature of the combination is that it is automatic and the design was so made as to render the danger of accident to a derangement of the apparatus very remote. The only attention which the apparatus now in use is receiving is for the car attendants to turn on the lights when they are wanted. On May 6 a Pullman parlor car eqipped with the system was exhibited with pleasing results on the Pennsylvania Railroad. The car is now in regular service on that road between Washington and Atlantic City and between Jersey City and Philadelphia and it has now made upward of 4,000 miles. The car is in charge of the porters, who give the lighting equipment all of the attention which it receives so that there is no expense for attention to the apparatus.

No belts are used to drive the dynamo, and the connection between the armature shaft and the car axle is positive, being made by spur gearing. The inside axle of one of the six-wheel trucks carries a split sleeve, to which the driving gear is secured, and upon which the bearing of one end of the dynamo is provided. The other end is hung by a spring connection to a stirrup hung from the truck transom. The dynamo and driving gear are entirely inclosed in a dust and water proof casing, and to guard the machine from shocks its bearing upon the axle as well as from the trucks is cushioned by a spring. In this way the uncushioned weight upon the wheels is not increased. The compactness of the design is worthy of note in passing. There is none too much space about a six-wheel truck, yet this machine is easily accommodated. The use of the sleeve already mentioned renders it unnecessary to alter the axles, and in fact no change in the truck was required for the reception of the apparatus. In the method of hanging the dynamo, employing a hinged connection near the stirrup end, provision is made for the vertical oscillations of the trucks with reference to the axle. The gear upon the axle meshes directly with the pinion upon the dynamo shaft with a ratio of three to one, and the gears are cut of steel, and they run in oil. Oil discs are provided to secure a circulation of the lubricant for the armature shaft and the openings in the casing at the sleeve are protected by dust guards. About 2½ horse-power will run the dynamo for supplying 28 lamps for a sleeping or parlor car.

The dynamo is shunt wound and is arranged to charge a set of 32 cells of Syracuse storage battery as well as to furnish current direct to the lights while running. The battery has a capacity of 250 ampere hours. The dynamo current is ingeniously controlled by an automatic regulator in the form of a solenoid and rheostat wired to the shunt field of the dynamo, the strength of whose current it controls. In addition to this instrument and operating with it is an automatic switch which is placed in a cupboard in the car. The armature of this switch is an electro-magnet mounted at its center and wired across the terminals of the dynamo. This armature operates in connection with fixed coils which together with the regulating solenoid already spoken of, are in the main dynamo circuit. The office of these controlling devices is to connect the dynamo to the batteries aod to the lamps whenever a certain speed of about 20 miles per hour is reached. An important feature of the regulation is that the charging current is made to correspond with the load or the number of lamps in use so that there is no danger of overcharging. The charging current is weakened as the number of lamps in use diminishes. This is one of the most ingenious parts of the apparatus and one which contributes largely to its success.

Sixty-volt lamps are used. The batteries are reported to be doing satisfactory work and they are guaranteed upon 10 per cent. depreciation per annum. Another automatic feature in the equipment is an attachment whereby the polarity of the circuit is not changed by a reversal of the direction of motion of the car. There are two sets of brushes, only one being in contact with the commutator at a time, and the brushes are changed automatically according to the direction of motion of the car axle. The regulation of its circuits by the automatic switches is satisfactory and the operation of the apparatus warrants the statement that it is beyond the stage of experiment and is a practical success. The advantages of a successful system of this kind need not be enumerated. Its first cost may be low and the attendance is not worthy of consideration. The maintenance will doubtless be a moderate charge, as the design and construction have been well executed. The address of the manufacturers is 14 Stone street, New York. Mr. Wilbur Huntington is President and General Manager of the company, and Mr. J. L. Watson is its Secretary.

(Established 1832.)

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

28TH YEAR. 66TH YEAR.

PUBLISHED MONTHLY

BY

R. M. VAN ARSDALE,

MORSE BUILDING...NEW YORK

G. M. BASFORD, Editor.

JUNE, 1897.

Subscription.—*$2.00 a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union.*

Subscriptions for this paper will be received and copies kept for sale by the Post Office News Co., 217 Dearborn Street, Chicago, Ill.

EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Special Notice.—*As the* AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL *is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 25th day of each month.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* **When a subscriber changes his address** *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

The paper may be obtained and subscriptions for it sent to the following agencies: **Chicago,** *Post Office News Co., 217 Dearborn Street.* **London, Eng.,** *Sampson Low, Marston & Co., Limited St. Dunstan's House, Fetter Lane, E. C.*

Much is expected this year from the short noon-hour discussions at the conventions, which were such a valuable feature last year. The whole success of the plan depends upon the selection of subjects, and if the committee having this in charge can bring up those topics concerning which the members converse upon the hotel piazzas between the sessions they will succeed. There is much interchange of information that is ordinarily carried out in conversations which ought to be had in the regular sessions. In conducting the discussions it is most desirable that the time limit should be fixed beforehand and let it be short. The best talk last year was had within the time limit originally set, and the desired sharpness as well as the practical, live character of the remarks will be best obtained by a rule to the effect that the ten-minute provision will not be amended by adding time, should the talk prove interesting. Preparation in advance contributes greatly to this part of the programme, and if but two or three minutes can be taken by each speaker the remarks will be put into shape beforehand.

One of the chief questions to be taken up in connection with the subject of interchange at the Master Car Builder's convention this year is the matter of the use of wrong material in repairing foreign cars. The whole foundation of the new interchange is involved in a recent decision of the arbitration committee in which the matter of the responsibility of a road handling a car as an intermediate line between one having made wrong repairs and the line owning the car was considered. The decision held that the intermediate road should be held responsible unless a card had been procured from the delivering road and this, if we correctly estimate the effect of the ruling, puts the inspection of cars with regard to repairs exactly upon the old basis of inspection for protection. Of course, when repairs are made to a car a repair card should be attached, and this should be accompanied by a defect card if the repairs are known to be wrong. If there is no other way to secure honesty in interchange, perhaps a return to the old methods is necessary. Sticklers for little things among cars inspectors can easily make trouble and delay by this inspection for wrong repairs, and much trouble may result from it. It would appear to be more in accordance with the spirit of the new interchange to make the owner responsible for wrong repairs which are not carded. Car owners will be the gainers in the end if cards are honestly used, and it is difficult to believe that they will be dishonestly omitted.

Comfort should come to those who feel that Americans are far behind Europeans in locomotive practice from the admission recently made by a leading English engineering journal to the effect that after giving due allowance for the enthusiasm in the stories of inventors, "Enough remains to deserve consideration, and to raise the question whether we have not, after all, something to learn from our professional brethren at the other side of the Atlantic." It is manifestly unwise to ignore or underrate the experience of others, and those engineers who are most progressive in the employment of good devices are close watchers of the practice of foreigners as well as that of their own countrymen. It is surprising to see the comments of the contemporary already referred to with regard to balanced valves employed upon American locomotives. Attention was called several months ago in these columns to the conclusion reached by our contemporary to the effect that it might be wise for Englishmen to employ balancing in consideration of the larger valves which are coming into use, and in concluding a description of a balanced valve recently tried in France, which by the way is of a type which has long been in use in this country, the following appears: "The whole value of the system lies in the tightness of the joints, which have to be made and preserved with the greatest care. Experience, however, has shown that the difficulties in this direction are not so great as they appear, and the fact that this form of valve is gaining popularity in both America and France seems to prove that it must possess advantages that counterbalance the evident objections to it." The strange part of the case is that 5,945 locomotives have been fitted in this country with practically the same valve as was described, and that the fact should not be known across the water. We should see to it that we are not equally uninformed as to good foreign practice. It is altogether likely that many of the troubles which are being experienced here with regard to locomotive working may have been met and solved by our neighbors, and while American practice is unique in many ways, requiring special treatment of various problems, there is undoubtedly much to be learned from experience abroad. Technical journals are doing their part in rendering the necessary information accessible.

The publication of the statement that Purdue University is to have a new experimental locomotive to replace the one which for six years has done service in its laboratory will be pleasing to all who are familiar with the work which has been done upon this plant. The new locomotive is to be so designed and equipped as to make it possible to obtain figures showing the results of changes in operation, the effects of which have up to this time been guessed at, but not known. The new locomotive will have "adjustable" cylinders; it may be run as a compound or as a simple engine; the steam pressure may be as high as 250 pounds, and, as far as it will be practicable to do so, the parts are arranged so as to compare various methods of operation and adjustment. While European engineers are making comparisons and forming con-

clusions concerning the working of locomotives based upon road tests, it is a source of great satisfaction and pride that we are enabled, by the stationary locomotive testing plant, to make comparisons and form conclusions which may be as reliable as if made upon stationary engines. And prior to the installation of the Purdue plant locomotive men were all working under such disadvantages as to practically discredit all of the numerical results obtained from tests. It is a pleasure to pay this tribute to the work done on this plant and to direct attention to the fact that much of the most reliable data ever taken from the locomotive were obtained upon it. The new equipment is timely. The questions concerning economy in locomotive operation were never so urgent as they are now, and much is expected from the new installation. It is entirely unnecessary to enumerate the new work which it will find to do. The mere mention of the provisions for changing the cylinders and the wide possible range in steam pressures suggests the importance of the subjects which will be taken up and the high and valuable character of the data already taken at Purdue is guarantee for the new work. The devotion of so much energy to locomotive subjects, than which there are none more important in transportation at this time, should earn the commendation of all railroad men to the University and to President Smart and Professor Goss. The school is to be congratulated, but not more than are the railroads, and one of the incidental features of the new work which will be greatly appreciated is the fact that the results of the tests are to be published by the University.

THE CONVENTIONS.

The appearance of green leaves on the trees and strawberries on our tables indicates the approach of the two conventions of the Railway Master Mechanics and Master Car Builders' Association, which have held their meetings annually during the past thirty years. Some of those who have grown gray in the service can recall many pleasant recollections which are associated with these reunions, and remember the hopefulness and the enthusiasm with which they took part in the proceedings in earlier days, when it seemed so much easier to effect reforms and put things right than it does now. The difficulties of doing this have inclined some to adopt the Chinese proverb which says that "a wise man adapts himself to circumstances, as water shapes itself to the vessel that contains it," and in the contemplation of reform to ejaculate *cui bono?* (what is the good?) and then let things alone. The two associations whose meetings will soon be held are, however, based on a conviction which is diametrically opposite to that kind of pessimistic feeling. The objects of these organizations are specifically set forth in their constitutions, and may briefly be summed up as the evolution of knowledge concerning the rolling-stock of railroads by the deliberation of its members. "Deliberation," the dictionary says, is "the careful consideration, and examination of the reasons for and against a measure;" and the constitutions of the two associations provide that such consideration shall be "by discussions in common, the exchange of information, and investigations and reports of the experience of its members." Dr. Johnson said: "Experience is the great test of truth, and is perpetually contradicting the theories of men." Although it is not specifically stated as one of the "objects" of these associations, in reality, just what Dr. Johnson indicated is done at every one of them; that is theories are submitted to the test of the experience of the members, and it need hardly be said that the theories often get the worst of it when they are subject to such trial.

In the organization of these associations it has been assumed that the members according to their natural abilities, antecedents, observations and the influences to which they have been subjected have, to a certain extent, apprehended more or less truth, and acquired valuable knowledge relating to their occupations. Such experience and knowledge is dispersed among the individuals who comprise these organizations, but is unequally diffused among them on account of the infinitely varied causes which influence their intellectual development and knowledge. In view of the purpose of these associations, which is the advancement of knowledge concerning rolling-stock, the problem evidently is to collect from the aggregate membership the most valuable knowledge of which they are possessed in the order of its value. The associations are not mere arithmetical machines—as some members seem to regard them—employed to collect and count individual opinions, but their function should be, that of assaying, as it were, the knowledge, experince and ideas of those who come to the meetings and of differentiating that which has much from that which has little value. The problem is to extract from the members and others the most useful knowledge of which each one is possessed. Every member who comes there has had a lifetime of experience and training. The natural endowments and faculties of no two of them are alike, the education of each has been different from that of all the others, and their experience has been of infinite variety. If it were possible to get photographs of the contents of the minds of all these people, it would form a mental panorama of surpassing interest and value. All that is usually done at the meetings is to obtain slight fragments or sparks of information which are evolved by the attrition of discussion.

The system which has been adopted for the elucidation of the subjects for consideration is well known to most of the readers of this journal. At each meeting a committee is appointed to select topics for investigation and to be reported on at the succeeding meeting. Special committees are then appointed to take up each of these and make reports thereon. The usual practice is that each committee prepares a circular of inquiry containing a series of questions intended to elicit the information which the committee wants. These circulars are sent to all the members, who are expected to reply to them, but like many other expectations; these are only partially fulfilled and usually only a small fraction of the members answer the questions propounded and often the answers give very little assistance to the committees in preparing their reports. In such cases they are either thrown upon their own resources, or, if a report is made up from the replies received, it assumes the character of the well-known composition which the schoolboy was compelled to prepare on the seasons, and who wrote that "there are four of them—spring, summer, autumn and winter. Some loves spring best, some summer, some autumn and others winter; but as for me, Give me Liberty or give me Death." To show that this is not an unfair parody of some of the reports, the following may be quoted. After giving a copy of their circular of inquiry, a committee appointed by the Master Mechanics' Association (to report on a subject which will not be named), said: "To this circular we received thirteen answers, the substance of which was the following:" (The "substance" of the replies was then given, and the following was the conclusion of the report:)

"We deem this subject of much importance, and regret that circumstances over which we had no control prevented us from giving it the time and consideration it deserves." Now it is believed that the committee who made this unsatisfactory report could have been subjected to the proper kind of mental pressure that it would have been found that in reality they did know a great deal more about the subject submitted to their consideration than their report indicated, and that their real lack was in a capacity for elucidation or expression. Herbert Spencer it was who said that "good exposition implies much constructive imagination, and of that, as displayed in the sphere of exposition, men at large seem to be almost devoid." This is strikingly true of some of the members of the two associations whose proceedings are being discussed. The great majority of them have been trained to do things and not to talk about and explain them, and, as has been said before, many of them would at any time rather clear away a railroad wreck than to write a report about it.

Any one who has attended any number of these conventions knows that by far the most interesting part of them are the colloquial discussions in which the members engage in pairs, trios,

and quadruples or more, outside of the regular meetings, sitting on the verandas of the hotels, or under other agreeable surroundings. The attrition of ideas under circumstances of this kind elicits thought and information, which, without such incitement, would have remained dormant. Such information is unrecorded, excepting in the memories of those who hear it, but the fact that under these conditions the members give utterance to ideas, facts and experience which, without the stimulus of conversation, would remain securely locked up in their own breasts suggests that if influences similar to those which lead members to reveal what they know could be brought to bear on them by the various committees, the latter would probably get a great deal more information than they do now by means of the circulars of inquiry alone. That is, if the committees could have various members of the association appear before them and relate their experience and tell what they know, subject to the interrogations of the members of the committees, it is absolutely certain that the latter would hear and learn much that without such interviews in all probability would not be brought to their knowledge.

This suggests the practical measure, that committees should be authorized—if such authority is needed—to hold meetings during the sessions of the convention for the consideration and investigation of the subjects in which they are to report, and to summons or invite such members, or other persons whom the the committee might select, to appear before them, to be interrogated and give information relating to the matters under consideration. Under the cross-fire and suggestions of questions and answers much would inevitably be brought out which a circular of inquiry or a public discussion will not elicit.

To carry out what is here proposed all that a committee would be required to do would be to fix upon a time and place for holding its meetings: then select persons to give evidence before them whose knowledge or experience it is thought would be valuable. The committee would then send or deliver a written communication to such persons inviting them to meet the committee at a certain place and hour. The response to such an invitation could of course be only voluntary, and questions would be answered only at the discretion of the person interrogated, but in all probability very slight limitations of this kind would be imposed in the scope of the inquiries.

In the contemplation of such a system, the list of subjects for discussion by the Master Mechanics' Association this year will make anyone interested in locomotives eager for the opportunity and the privilege of questioning certain members on some of the topics to be reported on. Take the first subject—"Exhaust Nozzles and Steam Passages." In view of the report published last year, and the series of articles which were published in the AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL on the same subject, it would be extremely interesting to know what the various members have been doing and what the results of their efforts have been. In the report and the articles referred to, the theory of exhaust pipes and the action of the blast has been for the first time fully elucidated by scientific experiments. Certainly some of the members must have profited by this new light which has been thrown on the subject, and they would be much more certain to tell what has been accomplished in a colloquy in a committee-room than they would in a general meeting of the association or in response to a series of printed questions, no matter how ingeniously they might be framed.

One of the most serious obstacles which has interfered with the success of the meetings heretofore has been the want of a good meeting-room. At fully one-half of the conventions which have been held during the past 25 years the proceedings have been seriously disturbed by noises of various kinds. The first action of the associations after they are called to order each year should be to appoint a committee on noises, whose duty it should be to maintain silence both inside and outside of the meeting-room. Such a committee ought to have the co-operation of a policeman, with authority to suppress instantly any kind of racket which will interfere with the proceedings of the meetings.

Trivial as this may appear, in reality, the fact that a large proportion of the members are often unable to hear what is going on has seriously interfered with the interest and diminished the usefulness of the proceedings. Much of the success of any meeting depends upon the arrangement of what may be called its mechanical environment—that is, the arrangement of the seats, the heating, cooling and lighting of the hall, the proper provision of certain things which are always needed in a technical meeting such as a black-board and chalk, facilities for displaying drawings, provisions for reporters, drinking water and a certain kind of mild policing the meeting-room to maintain quiet, which has already been referred to.

But the worst hindrances in the way of the interest and success of all deliberative and technical bodies are the bores and wind-bags who are always with us. It is hopeless to expect to suppress these entirely. The evil can be only mitigated. The bores are the people of inordinate prolixity, who delight in circumlocution, extended detail and trifling particulars, and who roll platitudes from their tongues with special delight, and as though they were uttering words of profound wisdom. The minds of such people are so sluggish that it seldom occurs to them that they are tiresome. No effective way has ever been adopted in this country to suppress this kind of people in deliberative bodies. In England, when a public speaker becomes insufferably tiresome, people in the audience suppress him by coughing. When twenty or a hundred people all begin to cough simultaneously, it is effective in at least indicating that they are impatient, and it usually suppresses the speaker. It is the practice to open the meetings of the Master Mechanics' Association with a prayer. A series of petitions—a kind of mechanical liturgy—might be prepared for these occasions, imploring blessings on the meeting, but all ending with the response—from being bores, good Lord, deliver us. The aggregate expense of holding such meetings as will assemble at Fortress Monroe is very large. Each minute and second that the conventions are in session represents a considerable number of dollars of cost. It is therefore of the utmost importance that this time should not be wasted by fatuous discussion or tiresome and useless talk. The difficult problem is to bring out and encourage profitable discussion, and at the same time suppress that which is stale and futile.

Any person who has attended many of the meetings of these associations and is familiar with their reports must have observed the tendency which has shown itself of following certain beaten tracks and habits of thought. Persons engaged in any one occupation are apt to lose sight of matters which are outside of their own jurisdiction. A looker-on will often see more of a game than the players. In a great game like that of managing a railroad it may very well be that a person in some other department, or those having jurisdiction over all, will see matters relating to cars and locomotives in quite a different light from that in which they appear to those whose daily duty it is to have control over them. It certainly would have the effect of broadening the views of those in charge of the mechanical departments if superintendents, general managers or presidents of railroads could be induced to express their ideas of the co-relation of such departments to all the others, or if successful manufacturers would give their impressions and experience as it relates to the construction or management of the rolling-stock of railroads. If it were arranged to have an address from some able railroad manager, manufacturer, engineer or possibly a college professor each year, it would seem as though it might be made an interesting and profitable feature of these meetings. This might be accomplished by a resolution instructing the executive committee to invite some such person whom they might select and who has such a knowledge of science or practical experience in matters pertaining to the operation of railroads as would be of especial value to the members of the association, to deliver an address on one of the evenings during the session of the convention. This might be made an annual feature of the meetings, and would bring a fresh influence to bear on the proceedings which could not be otherwise than healthful.

M. N. F.

LUBRICATION OF LOCOMOTIVE CYLINDERS.

The lubrication of locomotive valves and cylinders is a subject which is very much alive just now and in the hope of adding something of value to the discussions which have already been held during the past few months these paragraphs are presented.

It has been demonstrated that engines and steam pumps will run indefinitely without oil. That running in this manner admits of saving the cost of oil is axiomatic, but because of the fact that, next to initial condensation of steam, friction causes the greatest loss of power that occurs in the steam engine, the practice which in some branches of steam engineering seems to be gaining popularity, deserves sharp criticism. According to some authorities water is a lubricant, but while the statement that this is not true may be disputed, the affirmation is made that water does not lubricate the frictional surfaces of steam engines. It does prevent cutting, but cutting is usually due to heating and water tends to prevent heating. For this reason water is often erroneously considered a lubricant. Motive power superintendents do not voluntarily omit the lubrication of valves and cylinders, but it is true they are at present running locomotives when under steam without sufficient lubrication. They are just beginning to discover the fact and are trying to find a remedy. The idea of employing sight feed lubricators is not faulty. These instruments are the fruit of a vast amount of study and experiment, and they are beautifully successful in performing their office of delivering regularly a small amount of lubricant which may be nicely controlled. The trouble is unquestionably beyond the lubricator and it lies in the method of sending the oil to the steam chest. It lies in the pipe system employed, through which the oil is expected to travel a downward sloping course from the lubricator to a point perhaps 6 or 7 feet below it to the steam chest. The oil feeds well enough when the throttle valve is closed and when it is aided in its journey by vacuum, but the difficulty begins when the throttle opens and steam at a pressure but little below the boiler pressure is admitted at the steam chest end of the pipe. The increase of working boiler pressures during the past few years has been blamed for the trouble, but from experiments recently made it appears that it exists with pressures as low as 140 and 155 pounds per square inch, and these pressures have been used for years. It is a question whether the difficulty has not existed from the beginning of the use of the "tallow pipe" in connection with automatic lubricators. The results are more noticeable and more troublesome with high pressures, which are used to assist in meeting the vastly increased duty expected of modern locomotives, but it is not believed to be true that the high pressures cause the lack of regular feeding of oil. Accompanying the use of increased pressures longer locomotive runs are now the rule, which makes it more important to lubricate properly.

In experiments made upon a Western road last year it was found that with a boiler pressure of 140 pounds and the locomotive running at a rate of 25 miles per hour with wide-open throttle and the automatic lubricator feeding 60 drops of oil per minute, the oil did not appear at the steam chests until 30 minutes had elapsed. The oil pipes had been blown out with steam before this test, and were clean and empty when the locomotive started. More cases of similar character may be cited, but it is not necessary to state them. Some interesting indicator cards, taken by Mr. E. M. Herr and published in the September, 1896, Proceedings of the Western Railway Club, show that while one cylinder of a locomotive may be developing 795 horse-power, its valve being well lubricated, the other cylinder when the lubrication is deficient may give only 589 horse-power, a difference of 206 horse-power between the two cylinders. Without changing anything about the locomotive except the lubrication, the cylinders were made to indicate equal power, the difference in the first case being due to the springing of the rods and connections of the valve motion due to the high resistance of the poorly lubricated valve. This springing prevented the valve from opening and admitting enough steam, yet the lubrication was not defective enough to cut the valve during the time covered by the experiments. The same authority states that he has found a difference of 50 per cent. between the two cylinders of a locomotive from the same cause, when the eccentric rods were long and crooked.

One of the best writers on locomotive subjects in explaining the operation of automatic lubricators seven years ago, after speaking favorably of the automatic apparatus, said, gingerly, that the lubricant "is said to reach and oil all parts of the valves and cylinders." At that time he was in doubt as to the oil reaching its intended destination. The reason why the oil does not go through the pipes regularly is interesting. It is reasonable to suppose that at the opening of the throttle steam under boiler pressure is forced up into the long oil pipes, where it condenses, nearly filling the pipes with water, and the lighter oil cannot get down through the water under these conditions. Some of it may get through on account of the churning which it receives, but it is fair to ask the question as to why the oil should be expected to descend several feet against the force of gravitation. It is well known that the old hand oilers when placed in the cab would not feed against steam pressure from the chests, and why should the automatic lubricator be expected to do so? In stationary and marine practice the automatic lubricator is usually placed directly upon the steam pipe, or steam chest, or with the connecting pipe, when one is used, so short that condensation will not interfere with the operation.

A number of suggestions have been made for overcoming the difficulty on locomotives. Each of the prominent lubricator manufacturers has applied devices for the purpose of admitting steam into the oil pipe at the lubricator at or near the boiler pressure. This is done apparently with the object of counteracting the effect of the pressure from the steam chest when the throttle is open, and the admission of the steam at the lubricator is made automatic, depending upon the opening of the throttle. Without doubt these devices assist in securing circulation in the oil pipes. Another plan which appears to be successful in getting the oil down is to apply a steam ejector at the steam chest end of the pipe to suck the oil down. All of these involve complication apparently without getting at the trouble in the most direct way, which would appear to be to prevent the lodgment of condensed steam in the piping. In marine practice it has been found necessary in using the rising drop sight feed to place the lubricator below the cylinder and to arrange the oil pipe so as to be nearly vertical, with no dipping bends, and even then it has been found necessary to use a pipe not smaller than one-half inch in diameter. The working of this device depends upon the fact that oil is lighter than water, volume for volume, and many sight feed lubricators using the rising drop have been condemned in this practice, when the only trouble was that the lubricator was placed above the cylinder level, The easiest way out of the difficulty would appear to be to employ the falling drop sight feed, since the lubricator must be placed above the level of the cylinder, and to use oil pipes of such large diameters as to prevent the accumulation of suspended water. If a pipe is full of steam there will be no tendency to hold the oil back, even if the pressure fluctuates on account of the intermittent admission through the main steam valves. There can be no objection to the use of pipes of one inch or more in internal diameter if this is found to be necessary. One pipe of this size is better than two pipes, several valves, differential pistons and other complications found necessary in the suggested devices. It is expected that such a suggestion as this will call forth criticism, but it is believed that the problem is being attacked at the wrong end.

METHODS OF APPLYING ELECTRIC MOTORS IN SHOPS.

In the application of electric motors to the driving of machine tools, three methods of procedure naturally come up for consideration. The first of these is the application of a motor to each tool, the second is the grouping of tools and the installation of a motor for each group, while the third is the driving of considerable lengths of main shafting by motors, the belting to countershafts and the arrangement of the tools being practically undisturbed. There is something to be said in favor of each of these methods, but where the sole object is to save a large part of the

present losses in the transmission of power without too great an outlay of capital, the method of grouping tools and providing one motor for each group appears to find general favor. There are cases, however, where the gains sought are indirect; for instance, a large plant may be located on expensive ground where expansion is almost impossible, and its buildings may not have been originally fitted with cranes and other devices for the economical handling of materials; if the cranes, hoists and travelers cannot be put in without taking out the shafting and installing electric motors, it is apparent that the whole layout must be governed by the special objects sought. Special cases require special treatment, but where the object to be attained is the reduction of transmission losses, the question becomes chiefly one of a saving in power commensurate with the capital outlay and the future cost of maintenance.

Probably the direct application of a motor to each tool will in the majority of cases reduce the losses of power transmission to a minimum. But both the first cost and the maintenance of such an installation is large compared with the two other methods that have been mentioned. A motor applied to a single tool must be of sufficient power to meet the maximum requirements of that tool, and therefore the total horse-power of the individual motors is the horse-power required to operate all the tools at their maximum. Where tools are judiciously grouped the horse-power of the motors for each group can be somewhat less than that required for a simultaneous maximum output from all tools in the groups, as in average machine shop work the tools would not all be in operation at once. Consequently, because of the smaller total horse-power of the motors and the less cost per horse-power for large than for small motors, the expenditure is greatly reduced by grouping. It is also reasonable to assume that 100 horse-power in five units will cost less to maintain than if in from 30 to 50 units. Furthermore, while in the grouping of tools we still have friction loss due to more or less shafting and belting, this loss is partly offset by the greater efficiency of the large motors as compared with the small ones required for individual tools. Again, in providing individual tools with motors, one must choose between high-speed motors, with their attendant counters and belts for reducing the speed, and low-speed motors of greater size, weight and cost. It therefore appears not improbable that, all things considered, the net saving is greater when tools are grouped and each group driven by one motor. It should be borne in mind, however, that the heavier the tools the less the advantage of grouping, and in most large shops there are tools that unquestionably should be driven singly, even where grouping was wisely chosen as the general plan.

The third method mentioned, that of driving long lines of shafting by motors, has little to recommend it, except under exceptional conditions. It has, however, been seriously entertained in a number of cases where the lines of shafting were numerous and of moderate length, and where they were not all parallel to each other. Such an installation would probably be an improvement over belting and gearing, but it would appear better to subdivide further if electric motors are to be employed at all for driving machine tools. The whole question is a most interesting one, and is destined to be carefully studied in the near future. The flexibility of electric transmission and the additional uses that can be made of electricity about a large plant, are both arguments in favor of its use.

GAG MARKS IN RAILS.

A great deal of trouble is experienced on some railroads in keeping down the vibrations resulting from unevenness in the surface of the rails. These vibrations, transmitted through the springs to the car body, often become synchronous, and where a number of rails from the same lot are in line they become continuous. As soon as the car strikes the next lot of rails, which perhaps had required very little straightening, it rides smoothly, or rather seems to glide along. To some passengers this vertical motion is extremely annoying, not only because of the physical sensation, but on account of the humming sound accompanied by the rattling of all loose material in the car. If one pays close attention to this phenomenon, it will be at once evident when a lot of gag-marked rails are run over, and the cause will not be hard to discover.

When the rail is rolled it comes from the trimming saws red hot and is bent in the arc of a circle, head up, and the head on the convex side. This is done because the approximate equality of the thickness of web and foot causes them to contract equally, in cooling, while the metal in the head cools more slowly, so that when the flange and web have become rigid the head is still contracting, and if not corrected by bending in the contrary direction the rail would cool in the form of an arc with the head on the concave side. When the rolling temperature is not uniform the rails are sometimes bent too cold. When a section of rail is changed, the bending apparatus may not be regulated accordingly; one end of the bent rail may cool more quickly than some adjacent part, and for a number of other causes the rail may not cool straight, and subsequently must be bent in a machine intended for the purpose. Here the rail is laid on two supports and a vertical die, acting under the influence of eccentrics, cams or cranks, presses down upon the head of the rail, bends it so as to form a permanent set in the metal, and returns with a moderate motion. The face of this die is a dull, slightly rounded edge. The supports are usually fixed, and usually very little attention is paid to spacing them to suit the height of the rail being straightened. The results of carelessness or ignorance in this process are two in number, and both are serious. An undulating rail causing vibrations may be produced, or a point of weakness is developed often causing broken rails.

The remedy to the first is the use of a wider-faced curved die, the outline but slightly exceeding the curvature of the rail at its maximum deflection, and the placing of the supports farther apart.

In the second case the evil is not immediate, but is more serious in its final consequences. It has been repeatedly observed by trackmen that rails break most frequently at bolt holes in the joint in ordinary conditions, but that in cold weather, when most of the breaks occur, they are located in the body of the rail, and nearly always at gag marks, at a dent or cut in the rail head or at a section containing some imperfection of manufacture, such as slag, blow holes, pipes or external flaws.

At the top of the head of a gag-marked section there is a slight depression. Immediately below this, to the middle of the head, the metal has been compressed. The web is in its original condition and the base of the rail has attained a permanent set. While the rail is at its maximum deflection during bending, the head is in strong compression and the base in strong tension in extent beyond its limit of elasticity. When the rail returns straightened the head will be in tension, the web approximately neutral and the base in compression. Now, when a locomotive driving wheel runs over this section, it bends the rail slightly, but much more than it does the adjacent sections, because other sections are neutral and resist stress from the first, while in the gag-marked section initial tension in the head and compression in the base act with the wheel load against the counteracting resistances of the web, and the web is in considerable stress before the head and base are neutral. From this point the head comes into compression and the base in tension to return to their opposite condition again upon removal of the load. Steel that has once received a permanent set will resist fatigue much less successfully than neutral material, so that the ultimate ability to resist repeated stresses will also be much inferior to that of adjacent sections. So this gag-marked section keeps up the back and forth movement and in time breaks the rail just as an iron wire is broken by repeated bending back and forth. Interesting treatment of the subject of fatigue will be found in another column of this issue.

It is believed that in properly conducted mills the straightening of rails should be the exception rather than the rule and first-class passenger traffic should not be inflicted with imperfect product. Gag marks do not wear out, but rather increase in extent just as the hammering on the end of the rail flattens it after a time and its annoyances remain until it either breaks or is put out of service.

NOTES.

The Holland submarine boat, which was briefly described in the May issue of this journal, was successfully launched at the Nixon shipyards at Elizabeth, N. J., May 17, and a private trial will be made in the near future, after which she will be taken to Washington for an official test.

A new press for the San Francisco Examiner was recently shipped from New York to San Francisco, by way of the B. & O., the Chicago & Northwestern and Union Pacific. The B. & O. took it from New York to Chicago in three days, and it reached its destination in the remarkable time of ten days from New York, the distance being 3,406 miles. Ten years ago the average time for such shipments was 30 days.

The famous Yerkes telescopic lens, the largest made, was shipped from Cambridge, Mass., May 17, to its destination in the Yerkes Observatory. The lens was made at the works of Alvan G. Clark. It has a surface diameter of 41½ inches, and, according to the New York *Herald*, weighs 515 pounds. It is valued at $60,000, and represents five years of exacting work. The Wagner parlor car in which the lens was shipped had a large smoking-room at one end, and this was cleared for the lens. Every precaution was taken to prevent the slightest jar.

When computing the horse-power of a steam engine and you have multiplied together the piston area, the mean-effective pressure, the double-stroke, the revolutions per minute and all that, if you divide by 44,236 instead of by 33,000 you will have your power in kilowatts instead of in horse-powers. A kilowatt is a thousand watts. One horse-power is equal to 746 watts. If kilowatts must be had, and some people want them, it may save labor to get the horse-power in the old-fashioned way and then multiply by .746. Having the power in kilowatts, multiplying by 1.34, or more accurately by 1.3404825 +, gives the horse-power.—*American Machinist.*

Railroad Commissioners have for years been provided in a number of States for the management of questions which are continually arising with regard to transportation by rail, and the mportance of these branches of government is constantly growing. According to recent reports another State is about to be added to the list, as a petition has just been presented to the Legislature of the State of Delaware. This petition contained 10,000 names of voters, the petition itself being 60 feet long. This is an impressive indication of the desire for such legislation, which probably will not be ignored.

The Governor of the State of New York has signed the bill which allows the elevated roads in New York and Brooklyn to run through trains over the Brooklyn Bridge. The consent of the bridge trustees must be had and the bill provides that the fares shall not be increased by the roads which are to operate in this way. The trustees are expected to make a proper charge to the roads for the use of the structure. The trustees are authorized to prepare plans for the operation of trains in conformity to the report made in February by V. G. Bogue, G. H. Thompson and L. L. Buck, the engineers who were appointed to suggest a plan for the operation.

An interesting application of electric motors to high speed pumps was recently brought out in England. It consists of a motor and pump mounted upon a single cast-iron base and having a common shaft. The motor rotates the shaft and the pump cylinders, which are three of the trunk type, are arranged as in a brotherhood engine, and are driven from one crank. The cylinders are made in one casting, and the valves are arranged so as to permit of a by-pass for lightening the motor load in starting. The speed of the shaft is 700 revolutions per minute. The valves are large in area with small lifts, and the cylinders of the pumps are large in diameter with very short strokes. These combinations are used to give high-pressure water service.

It is of interest to note that educational institutions are paying more attention than formerly to the subject of railroad signaling. Recently Mr. Charles Hansel, C. E., Vice-President and General Manager of the National Switch and Signal Company, was requested by the faculty of Cornell and also of Lehigh University to lecture before their engineering students upon the general subject of signaling. Mr. Hansel is known as one of the best authorities upon this subject and the lectures were explained practically by an exhibit of full-sized apparatus, such as is employed in regular signaling practice upon the railroads. If this idea of getting outside lecturers who are thoroughly in touch with practical work to instruct students is followed up it will not be long before the requirements of safe train operation will be properly appreciated in this country.

Some interesting figures are given by Superintendent Charles Selden, of the Baltimore & Ohio Railroad Telegraph, which give a good idea of the immense importance of the telegraph to the operation of the railroad. The average number of messages handled every day on the Baltimore & Ohio system, exclusive of train orders, is 53,000. The Baltimore & Ohio Company has 22,252 miles of telegraph wire, of which the company uses 7,240 miles for its own business, while the rest is leased to the Western Union Telegraph Company. There are 384 telegraph offices on the line, of which 234 are reporting Western Union offices. In the telegraph department of the railroad company 750 men are employed, exclusive of linemen, and the service of the company's plant is considerably augmented by the use of multiplex systems of telegraph.

The influence of railroad building in localities where primitive transportation methods have been in vogue is commented upon by Transport, in stating that the railroads of Rhodesia, South Africa, are expected to reduce the cost of traveling in the interior to one-third the present rates and to reduce the cost of food and other necessaries of life to about one-fifteenth of the present figures. The road is now open to Palapye, 1,200 miles from the cape, and 340 miles have been built within a year. The remaining 200 miles to Buluwayo are to be built immediately. On the 340 miles referred to there are but two or three stations, although trains will stop at each passing point for the convenience of passengers. The journey to Buluwayo will occupy about three days and nights. The locomotives for this road are made by Messrs. Neilson & Company, of Glasgow.

In his presidential address before the Institution of Naval Architects, Lord Hopetown gave the following shipbuilding programme for the coming year, which includes 108 new vessels to be constructed or completed for the British navy, the aggregate displacement being 380,000 tons, and the aggregate indicated horse-power being 800,000:

14 battleships.
8 first-class cruisers.
9 second-class cruisers.
2 sloops.
4 twin screw gunboats.
52 torpedo-boat destroyers.
8 light draft steamers for special service.
1 royal yacht.

The recent purchase of 58,000 tons of 80-pound steel rails by the Receivers of the Baltimore & Ohio Railroad Company at a cost of about $1,000,000 is another evidence that Messrs. Cowan and Murray intend placing the B. & O. in first-class physical condition. It is understood that these rails will be placed in the track as soon as possible, and that by fall the tracks between Baltimore and the Ohio River will practically be entirely relaid with new steel and new oak ties. As fast as the old rail is taken up it will be relaid on the less important branches, or used in extending much-needed sidetracks. During the winter the company has also been extending a great deal of its third track between Cumberland and Baltimore. So much has been built that by the middle of the summer there will be no further delays to the passenger trains, as the freight trains can be easily operated on the additional tracks.

According to *Bradstreets*, a company has been incorporated in the City of Mexico with a million dollars capital, the larger part of the shares being taken by Pearson & Son, English contractors having in hand the drainage of the valley of Mexico and the port works at Vera Cruz, with a few Mexican shareholders. The new company will be known as the Mexican Land, Navigation and Railway Company. The first object of the company is to build a railway from some suitable point on the National Tehuantepec Railroad to a desirable point in the State of Vera Cruz. The government gives a subsidy of over 8,000 acres of public lands per kilometer of railway constructed. On some 400,000 acres of land thus acquired the company will settle European and other colonists. Among other plans of the company is to acquire railways in the southern part of Vera Cruz, and also the building of new lines. Part of the main railway line has already been located, and construction will begin in two months.

A test of chemical fire extinguishers of different makes was recently made at the car shops of the Pennsylvania Company with a view to determining which kind should be used on the railway trains of that company in compliance with the Ohio State law. The law provides that one coach on each train shall be provided with an extinguisher the first year and one additional coach each succeeding year until all are supplied. The tests were made under the supervision of the State Railway Commissioner, on whom devolves the duty of selecting the kind of extinguisher to be used. The tests were witnessed by the representatives of a large number of railways. The extinguishers were of two, three or four gallon capacity. In making the tests fires of the same kinds of combustible were burned from 17 to 30 seconds, when the extinguisher was applied. One of the extinguishers was exhausted in 40 seconds, and the fire had to be put out by the fire department. Another was exhausted in 1 minute, when the fire was almost out. The other extinguishers succeeded in putting out the fire in times ranging from 1 minute to 1 minute 35 seconds.

The experimental tank which is to be constructed at Washington by the Navy Department for trials with models of new ships will be the largest basin of its kind under cover in the world, says the *Marine Review*. Its dimensions will closely approach those of some of the largest drydocks, and the depth will be sufficient to float many of the smaller ships of the navy. It will be covered on all sides and the water will be supplied by the city reservoirs or pumped from the Potomac River. From end to end the tank will be just 500 feet long and 50 feet across, and the water space will be 475 by 43 feet. Its depth will be 14 feet. Running across, close to the water, will be a carriage upon which there will be attached a dynamometer to register the resistance due to towing a model through the basin. Models, varying in size from 10 to 20 feet of every new ship to be built will be attached to this machinery and drawn through the water. The wave motion will be observed and the resistance it offers will be calculated. The models will be plain affairs, constructed only with a view to presenting closely the actual lines of the ship it is proposed to build. Through the experiments it is estimated that the plans of all proposed vessels can be improved and valuable information gathered for use in designing the lines of ships. The cost of the tank will be $100,000.

A new hospital car in use on one of the Belgian railroads is described by Consul Morris, of Ghent. The interior is divided into a main compartment, a corridor on one side and two small rooms at the end. The largest compartment is the hospital proper; it contains 24 isolated beds on steel tubes hung upon springs. Each patient lies in front of two little windows, which may be closed or opened at will. Each bed is provided with a little movable table and a cord serves to hold all the various small objects which the patient may need. The corridor on the outside of the hospital chamber leads to the linen closet and the doctor's apartment. In the latter is a large cupboard. The upper portion is used for the drugs; the lower part is divided into two smaller compartments—one serving as a case for surgical instruments, the other as a receptacle for the doctor's folding bed. The hospital compartment is carpeted with linoleum or other material to deaden the sound of walking. Various trapdoors in the floor, when opened, disclose to view an ice chest, a compartment for the disinfection of soiled lined, and a provision cellar. If necessary, a portion of the hospital chamber may be transformed into an operating-room for urgent cases. Finally, as is customary in that country, a small chapel for religious worship is provided. This car will be put in charge of a surgeon, doctor and nurses, and will be chiefly used to carry invalids from Belgium direct to the miraculous cure of Lourdes, in France.

In a paper recently read by Mr. D. C. Jackson in London upon the subject of the use of electric power for factories brought out a number of interesting facts. The author's conclusions were that a voltage of 220 or 250 was preferable even where lighting formed an important part of the work, as 220-volt lamps are as efficient as the more common 110-volt type, and he thought that operation by motors is much more economical than the old method of using a main driving engine and long lines of shafting and belting. One example was cited where the cost of repairs for a given time on 140 motors of 1,500 aggregate horse-power was less than the former cost of repairs to belts under similar circumstances. In another case where rope driving was formerly employed on a crane, it was found that 15 horse-power was uselessly employed in driving the rope alone, and but 2 horse-power additional was needed to drive the crane itself. Two 3 horse-power motors now operate it, and the saving effected will, it is estimated, pay for the cost of the change in one year.

The "Alley L" road of Chicago is to be equipped with electric traction on a plan which is a departure from ordinary methods. The usual system uses a single motor car for a train of three cars, the motor being capable of developing about 250 horsepower. It is found that the speed of trains is limited to from 11 to 13 miles per hour on account of the lack of tractive power possessed by the motor car. The system for the road referred to contemplates the use of two 50 horse-power motors upon each car, each of which will take its current from the third rail, but will be under the control of the motorman on the leading car. Each car will therefore be capable of locomotion by itself, but when forming any part of a train it will be under the same control from the leading car as if drawn directly by it. Numerous advantages have been mentioned as expected results of the system. The power will be distributed in accordance with the load, and the latter will give sufficient tractive force to enable a schedule speed of 18 miles an hour to be maintained. The equipment necessary is of a class that can be purchased in the open market. If desired, cars can be dropped from a train at any point and handled in yards independently.

Personals.

Mr. C. P. Walker has been appointed Purchasing Agent for the Indiana & Illinois Southern.

Mr. W. de Sanno has resigned as Master Mechanic of the Chicago & Southeastern Railway and the position has been abolished.

Mr. George M. Cumming has been elected First Vice-President of the Erie Railroad, with office at 21 Cortlandt street, New York.

Mr. Robert H. Gardner, for more than 40 years foreman in the Pennsylvania shops at Altoona, died at Hagerstown, Md., on the 15th instant.

The jurisdiction of Mr. J. Campbell, Master Mechanic of the Lehigh Valley at Buffalo, has been extended over the car department of the Buffalo division.

Mr. T. G. Duncan has resigned as Assistant Master Mechanic of the Baltimore & Ohio Southwestern at Chillicothe, O., and is succeeded by Mr. John Hair.

A. J. Menter has been appointed Master Mechanic, of the Oconee & Western Railroad, with headquarters at Dublin, Ga., vice J. A. Long, resigned.

Mr. Charles M. Heald was chosen President and General Manager of the Chicago & West Michigan at a meeting of the Board held in Boston on April 27.

Mr. A. B. Cherry has been appointed Master Mechanic of the Everett & Monte Cristo, with headquarters at Everett, Wash., to succeed Mr. W. Irving, resigned.

Mr. W. E McCarthy has been appointed Master Mechanic of the Carabelle, Tallahassee & Georgia Railroad, with headquarters at Lanark, Fla., to succeed S. A. Sheppard, deceased.

Mr. P. E. Garrison, formerly Division Master Mechanic of the West Shore, at East Buffalo, N. Y., has been appointed Assistant Superintendent of Motive Power of the same road.

At a meeting of the directors of the Northern Pacific Railroad Company, held in New York City April 29, Mr. E. W. Winter presented his resignation as President of the company.

Mr. J. Cullinan, Master Mechanic of the Norfolk & Western at Portsmouth, O., has been appointed foreman of the shops at Portsmouth, and the office of Master Mechanic is abolished.

Mr. J. B Braden, foreman of locomotive repairs of the Pennsylvania lines at Columbus, O., has been appointed Assistant Superintendent of Motive Power and cars of the Wheeling & Lake Erie.

Mr. O. P. Dunbar, for 14 years General Master Mechanic of the Wheeling & Lake Erie, has been appointed Superintendent of Motive Power and Cars of the same road, with headquarters at Norfolk, O.

Mr. Charles S. Churchill, for many years Engineer of Maintenance of Way of the Norfolk & Western, has been appointed Chief Engineer of that road, to take effect May 1, with headquarters at Roanoke, Va.

Mr. William Renziehausen, formerly with the Pittsburgh & Western, has been appointed Assistant Master Mechanic on the Atchison, Topeka & Santa Fe Railway, with headquarters at Fort Madison, Ia.

Mr. John S. Wilson has been elected President of the Baltimore, Chesapeake & Atlantic, to succeed Mr. John E. Searles, who has resigned. Mr. Wilson entered railroad service as solicitor for the Baltimore & Ohio in 1862.

Mr. R. P. C. Sanderson has been appointed Master Mechanic of the line of the Norfolk & Western east of Roanoke, with office at Roanoke, Va. H. A. Gillis has been appointed Master Mechanic of the line west of Roanoke, with office at Roanoke.

Mr. J. D. Landis has been appointed Purchasing Agent of the Philadelphia & Reading, with headquarters at Philadelphia, Pa., to succeed Mr. Albert Foster, deceased. Mr. Landis has been Assistant Purchasing Agent of the company for the last five years.

Mr. J. A. Carney, formerly in charge of the testing laboratory at Aurora, Ill., has been appointed Master Mechanic of the St. Louis Division of the Chicago, Burlington & Quincy, with headquarters at Beardstown, Ill., in place of Mr. J. F. Deems, promoted. Mr. Max Wickhorst takes Mr. Carney's place as Engineer of Tests.

Mr. W. Green, General Foreman of the San Antonio & Aransas Pass at Yoakum, Tex., has been appointed Division Master Mechanic at Yoakum, and Mr. D. S. Hassett, General Foreman at San Antonio, Tex., has been appointed Division Master Mechanic at the same place.

Mr. John Warwick, General Purchasing Agent of the Seaboard Air Line, has resigned, to take effect May 1. He has held the position since January 1, 1896, and was formerly for eight years Purchasing Agent of the Chicago Great Western. He will be succeeded by Mr. O. D. Ball, Jr.

Mr. J. F. Deems, who was recently appointed Master Mechanic of the St. Louis Division of the Chicago, Burlington & Quincy, has been made Master Mechanic of the Iowa lines of the same system, with headquarters at Burlington, Ia., to succeed C. W. Eckerson, deceased. A very touching tribute was paid to Mr. Deems by his subordinates upon his departure from Ottumwa, which indicates that cordiality and respect may accompany strict discipline.

The following appointments on the Grand Trunk Railway are announced: Mr. J. W. Harkom to be Master Mechanic Eastern Division, headquarters Montreal, P. Q.; Mr. W. D. Robb to be Master Mechanic Middle Division, headquarters Toronto, Ont.; Mr. W. Ball to be Master Mechanic Northern Division, headquarters Allandale, Ont.; Mr. A. A. Scott is appointed foreman at Belleville, Ont., vice Mr. W. Ball, promoted. Mr. H. Roberts, Master Mechanic of the Western Division, at Fort Gratiot, Mich., and Mr. J. A. Slack, Assistant Master Mechanic of the same division at Battle Creek, Mich., have resigned, and Mr. Robert Patterson, General Foreman of the locomotive shops at Port Huron, is appointed Master Mechanic at Fort Gratiot.

New Publications.

History of the Baldwin Locomotive Works, 1831-1897. 86 pages, standard size (6 by 9 inches); cloth, illustrated. J. B. Lippincott Company, Philadelphia, 1897.

The letterpress, binding and illustrations of this book are excellent and its whole appearance is creditable both to the publishers, and to the firm whose history it contains. The frontispiece is a steel engraving of Matthias W. Baldwin, the founder of the Baldwin Locomotive Works. The book opens with a plan of the works in Philadelphia, showing the space occupied to amount to six and one quarter city blocks and the buildings are numbered and described. The history itself follows this plan, and from the fact that the origin of these works was at the inception of steam railroads in this country, and also because the concern has been and is in the front rank of its line in the world their history is practically the history of the advancement in locomotive building from 1831 to the present time. The industry was started by Matthias W. Baldwin, who in 1817 was a jeweler in the service of Messrs. Fletcher & Gardner in Philadelphia. Soon after that date he took up steam engine building and he began the construction of his first locomotive, a miniature affair, April 25, 1831. The history records the growth of the business of locomotive building from this time and presents a view of the difficulties encountered with regard to obtaining the services of machinery and qualified artisans which necessitated the doing of most of the earlier work by Mr. Baldwin himself before he could educate his assistants. The first locomotive was christened "Old Ironsides," and was tried on the road in 1832. Interesting facts in relation to the advent of steam locomotives are presented and extracts from the press of the day are reproduced. Considerable attention is given to the details of early locomotive construction and some of the features of present designs are shown in embryo in these engravings. A list of the number of locomotives built during each year from 1866 to 1871 is interesting. In 1866 the number built by this concern was 118, and in 1871 it was 331 and later on in the work another list shows that in the year 1896 547 locomotives were built which brought the total number up to 15,000. That year, however, was far behind the best as to the number built, for in 1890 946 locomotives were turned out. It is shown that while 30 years were occupied in building the first thousand locomotives in the single year just mentioned nearly that number were constructed. The illustrations present a number of noted special engines, such as the Decapod for the St. Clair tunnel, the Pike's Peak engines, the Westinghouse-Baldwin electric locomotives and the "single driver" engine of the Philadelphia & Reading, as well as others equally well known. The book closes with a statement of the number of men employed by the works, the number of departments and machines, and the weekly and daily consumption of material. The work contains an interesting record and is one which will be preserved for reference. The only criticism offered is that the title is not placed upon the back where it may be seen when the book is placed among others on a shelf.

Catalogue of the Schenectady Locomotive Works. 224 pages bound in cloth, standard size (6 by 9 inches). Illustrated.

An exceedingly handsome catalogue has just been issued by the Schenectady Locomotive Works, which is a useful compilation of

information concerning the many types of simple and compound locomotives which have been recently built by this concern. The illustrations are excellent vignetted, half-tone reproductions of photographs, and each locomotive is described by a list of the leading dimensions and weights. These lists include a number of notable designs of powerful modern locomotives. The catalogue is carefully indexed and the contents classified. The designs are also listed under the names of the roads.

A valuable feature is added as an appendix in the form of a series of formulæ and tables for the purpose of obtaining the power of locomotives for assistance in designing. Tables to the number of ten give locomotive power, train resistance and piston speeds for various conditions, and these are explained for convenience in using. The book is "Dedicated to the American Railway Master Mechanics' Association, whose engineering skill and devoted efforts have contributed so largely toward placing the American locomotive in the front rank of the motive power of the world." In the preface attention is directed to the fact that these works have been rebuilt and materially enlarged during the past five years: that modern buildings have been erected, and that the most approved designs of electric, pneumatic and hydraulic apparatus has been installed. The annual capacity of the works is 450 locomotives. The catalogue is from the press of the J. B. Lippincott Company, of Philadelphia. A copy should be obtained by every motive power officer for the value that it will be in comparing designs. We must offer the criticism that the work would have been improved by inscribing the title upon the back where it could be seen when placed among other books upon a shelf. The letterpress and binding are first-class, and the publishers and the Schenectady Works are to be congratulated on its appearance.

Trade Catalogues.

[In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. These are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

Metropolitan Double Tube Locomotive Injectors, manufactured by the Hayden & Derby Manufacturing Company, 111 Liberty street, New York. 20 pages, 9 by 12 inches (standard size).

This pamphlet is devoted entirely to descriptions of the injectors manufactured by this company, giving special attention to those for locomotive use. The explanations of the various patterns of injectors are accompanied by excellent engravings showing the apparatus in section, and beside the general description the catalogue contains a statement of the requirements of a perfect locomotive injector, with the reasons for various difficulties ordinarily found in practice. The increase of steam pressure carried upon locomotive boilers, and the exacting service required of locomotives renders the subject of boiler feeding an important one, and too much trouble can hardly be taken to insure satisfactory feeding. The catalogue is arranged with a view of facilitating the ordering of repair parts. The letter press, paper and illustrations are good.

Water Pumped by Compressed Air. Catalogue No. 72 of the Ingersoll-Sergeant Drill Company, Pneumatic Department, Havemeyer Building, 26 Cortlandt street, New York. 32 pages, standard size, (6 by 9 inches).

This catalogue is devoted to the purpose of describing and illustrating the application of pneumatic power to the pumping of water. It contains information with reference to air compressors and states the strong points of the machines manufactured by this company, but the larger portion of space is given to the Pohle Air Lift, pumping from artesian wells by means of compressed air without the use of any moving parts. The description states how the system operates; treats of its economy and efficiency and presents the special advantages claimed for it. Among these the increase of the yield of wells is mentioned, together with the cooling of the water, the freedom from trouble with sand and the availability of the full area of the well. It is also pointed out that the compressor may be located at any desired distance from the well, that the water is aerated and that one compressor can be used for a group of wells. The pamphlet is planned with a view of interesting those who have pumping plants and those who are to install them, in the system and comparisons between the cost of this method and others are invited. The engravings illustrate a number of Pohle air lift plants and include compressors furnished by this company for other methods of pumping. Among the engravings is one of a duplex class "C" compressor installed at Bloomington, Ill., which with the Pohle air lift has a capacity of 4,000,000 gallons of water per day. The number of air lift plants now in service is surprising, and those who have wells to which the system is applicable will find the catalogue interesting and valuable.

The Balanced Compound Locomotive.

The new balanced compound locomotive, No. 1, which has been recently built at Sparrow's Point, Md., and which is the property of the Balanced Locomotive and Engineering Company, of New York City, has been received at Purdue University, where, it is expected, it will soon be tested on the locomotive-testing plant of that institution. The tests will be conducted by Professor Goss, acting under the direction of Mr. Geo. S. Morison, Vice-President of the company. From the peculiarity of the design of many parts of this engine, the results of the tests will be awaited with much interest by railroad men. As is doubtless well known, this engine is of the 10-wheel Atlantic type. It is a four cylinder compound, each cylinder being independently connected to the driving axle. No eccentrics are used, the valve mechanism being operated conjointly from the cross-head and crank-pin. The firebox also is a departure from the ordinary design.

The ceremony of launching a new vessel of the North German Lloyd Steamship Company took place on Monday, May 3, at the Vulcan Works, Stettin. The *Kaiser Wilhelm der Grosse*, when completed, will be the largest vessel afloat. The vessel is 649 feet long, has a beam of 66 feet and a draught of 43 feet. She has a displacement of 20,000 tons and her screws are driven by two triple-expansion engines of 30,000 horse-power, capable of propelling the vessel at a speed of 22 knots.

Profits in Manufacturing Armor Plate.

The recent publication of the faets with regard to the mess into which the armor plate question has been thrown has created wide interest, and in justice to the firms having gone into the business the figures showing what the profits of manufacture are should be known. The following communication from the Carnegie Steel Company to one of its correspondents is given below with acknowledgment to the *Iron Age*:

Sir: There seems to be an impression prevalent that we have made unusual profits on armor. We beg your kind perusal of the following statement, which we believe must correct this most unfounded impression.

IN THE MATTER OF THE COST OF ARMOR PLATE.

Deductions from the figures now before Congress in the report of the Hon. H. A. Herbert, late Secretary of the Navy.

Total value of the Carnegie armor plant $3,376,019.77

Average date of expenditure, determined from same report: March, 1892.

Armor shipped October, 1891, to March, 1897, inclusive, 12,482 gross tons—an average of 2,270 tons per year.

Proceeds of same, $6,764,476.87 or .... $541.94 per ton.

	Per ton.
Secretary Herbert's basis of cost of manufacture, labor and material, excluding maintenance	$197.78
Maintenance, 10 per cent. on cost of plant, excluding land and interest, $306,101.97 per annum, or, on 2,270 tons*	134.84
Total cost of armor plate as established on Secretary Herbert's basis	$332.62

SUMMARY AND DEDUCTIONS.

12,482 tons of armor shipped.		
Proceeds, per ton	$541.94	$6,764,476.87
Cost, per ton	332.62	4,151,762.87
Profit, without allowance for depreciation	$209.32	$2,612,714.00
Or, $175,039 per annum.		
Investment—Plant		$3,376,019.77
Working capital		750,000.00
Total		$4,126,019.77
Annual return, without allowance for depreciation or for interest on investment, about 11½ per cent.		
Total cost of plant		$3,376,019.77
Deduct—Land	$240,000	
Salvage†	1,000 000	1,240,000.00
Loss, when navy shall have been completed, in say 15 years.		$2,136,019.77
or $142,401 per annum.		

Net revenue for manufacturing, $332,638 per annum, or 8 per cent. per annum.

* It may be explained that 10 per cent. of cost of plant for maintenance means all repairs to plant and new machinery required by reason of changes in methods, which are very frequent in the manufacture of armor, but does not include any charges for interest or depreciation.

† Salvage here means what can be saved out of the wreck when the works built for armor plate making shall be no longer used for that purpose.

As you will see by this statement, it is impossible for us to make more than a moderate return from this the most difficult branch of steel manufacture. This is largely true because the government only orders from us on an average sufficient armor to run our enormous plant to one-third of its capacity. Quantity in the manufacture of armor is the most important item in determining the cost of armor. This was clearly shown by the bid of the Illinois Steel Company, in which they specify that a minimum of 6,000 tons per year should be provided, and that they should receive $100 per ton on all under 6,000 tons per year. If this had been a condition of our contracts with the government, we would have been paid $2,280,000 during the past six years for this one clause alone.

As you will clearly see from the above statement, it is impossible for us to make even a moderate return where only 2,000 tons of armor per year are ordered, even at present prices.

If the government will give us an average of 2,000 tons of armor per year, at present prices, we will very gladly make all over that quantity at $400 per ton.

In conclusion, we beg you will give the above statement careful consideration and note especially that no charge has been made for depreciation in value of plant when the navy shall have been completed, nor any charge for interest on investment. It will be seen by the rate of profit that the assumption that the plant has been paid for out of armor plate contracts is unfounded.

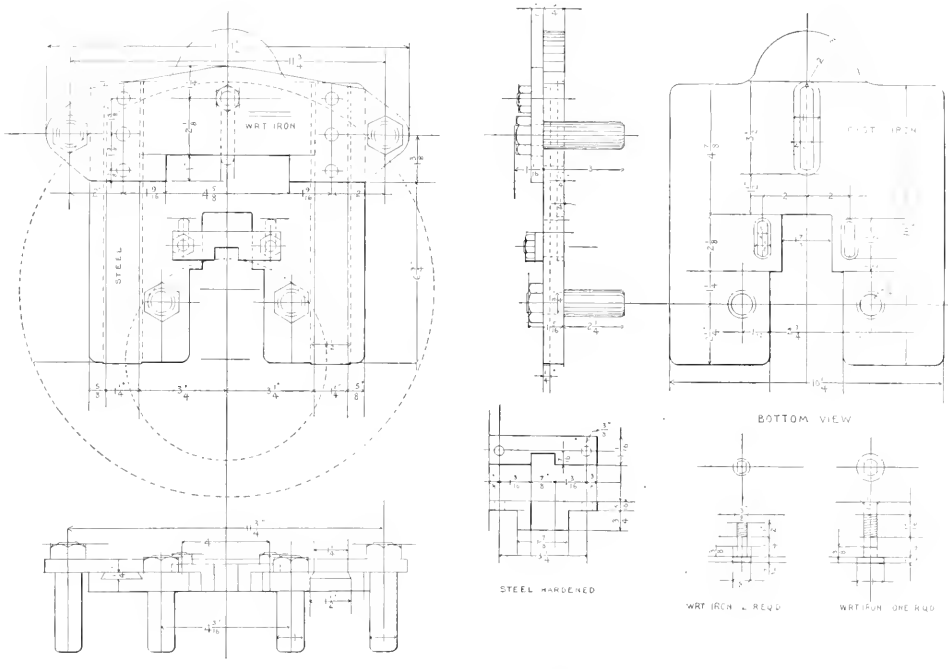
Very respectfully yours,
THE CARNEGIE STEEL COMPANY, LIMITED.
PITTSBURG, April 17, 1897.

President Frank Thomson, of the Pennsylvania Railroad Company, who has just returned from an inspection tour of the lines in the West, said he believed "the country will in a short while begin to feel the effects of a general trade revival."

A Keyway Jig for Eccentrics.

In the accompanying illustration we show a handy jig used in the West Milwaukee shops of the C., M. & St. P. Ry. for laying out the keyways in eccentrics. The practice is to have the keyway located on the line passing through the center of the axle and the center of outer diameter of the eccentric, and it is evident that the exact location is not readily and accurately obtained by hand methods.

The jig consists of a cast-iron plate, $\frac{3}{4}$ inch thick, which carries two pins that are placed in contact with the bore of the eccentric when the jig is applied. The plate has two dove-tailed grooves in which pieces riveted to a $\frac{1}{4}$-inch wrought-iron plate slide. This latter plate also carries two pins that are intended to fit against the outer circumference of the eccentric. It is evident that if the jig is applied to an eccentric in the manner indicated in the upper left-hand view of our engraving and if after the two outer pins are brought as close to the inner pins as the eccentric will permit the two plates are clamped together firmly by the bolt provided for that purpose, the center line of the jig will give the correct position of the keyway. In setting the jig it is applied in approximately the correct position and moved to the right or left until the position is found in which the two pairs of pins are closest to each other, and the plates are then clamped together. A small plate containing a notch the exact size of the keyway is adjustable for different diameters of axles, and from it the keyway is scribed. Once set the jig need not be again adjusted for other eccentrics in the same lot if each eccentric is accurately bored and turned, though it is easily set for each individual eccentric if the necessities of the work require it.



Jig for Marking Eccentric Keyways—C. M. & St. P. Railway.

Communications.

Counterfeit Magnolia Metal.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

We desire to inform you that the firm of Sugden, Pound & Wagner, of London, former selling agents for Magnolia metal in Europe, and who traded under the name of the Magnolia Anti Friction Metal Company of Great Britain, by special permission of our company, has been dispossessed of their agency by the English courts and that our London office and our foreign business are now under the management of Mr. Chas. B. Miller, the President of this company.

We beg also to inform you that Messrs. Sugden, Pound & Wagner were recently perpetually enjoined. together with the Atlas Metal Company, Limited, of London, John Sugden, Max Wagner, Arthur George Brown, the Globe Engineering Company, Limited, of Manchester, the Atlas Bronze Company, Limited, and the Atlas Bronze Company, from continuing the fraudulent business of making an anti-friction metal and branding it with the trade mark of the Magnolia Metal Company, of New York, imitating their ingots, marking the boxes in which the metal is packed, "Made in the United States," and otherwise deceiving and imposing upon purchasers of anti-friction metal in Great Britain and Europe.

Justice Collins heard this case, and gave judgment against Sugden, Wagner, Brown, the Globe Engineering Company, Limited, and others, for selling counterfeit goods and deceiving the public by representing that the goods were made in the United States by the Magnolia Metal Company.

An appeal was taken from the injunction above referred to. This appeal was tried before the Court of Appeals, Lord Esher presiding, and the perpetual injunction granted by Justice Collins was confirmed. It was in this trial that Lord Esher denounced the action of the parties above named, and characterized their performance as "a disgusting fraud."

It has come to our notice that parties in this country have attempted to perpetrate a similar fraud, and we now have one Western firm in the courts over this matter, and we desire through your columns to warn the engineers and the general public, users of anti-friction metal, against these fraudulent attempts to pirate and appropriate the use of our trade marks and name of our metal.

Every bar of Magnolia metal bears the steel stamp of the magnolia flower and the impression of the steel die "Patented June 3d, 1890, and "Manufactured in the United States," with the exception of the metal manufactured by this company in Russia. which bears the stamp of the magnolia flower and the words "Manufactured in Russia." MAGNOLIA METAL COMPANY.

NEW YORK, May 10, 1897.

Good Advice to Students.

In an address recently delivered before the engineering students of the University of Wisconsin, Mr. J. N. Barr gave some excellent advice, which is equally good for older men. He impressed the importance of little things, and for an example took an axle and its bearings to show the number of trivial things which might cause accident and disaster. The advice given is contained in the following paragraphs taken from the address:

Every one of you has undoubtedly heard the remark that so and so is a very smart person but he does not seem to get along. There must be a screw loose somewhere. The remark indicates that there must be some deficiency not very apparent. possibly so slight as to be imperceptible to the average observer, and yet a deficiency that spreads its blighting influence over the entire life work of the unfortunate, destroying his hopes and the hopes and expectations of his friends. This is true, even though no glaring faults such as dissipation, negligence, etc., exist. It is often true of the best and brightest of students. It has been the occasion of wonder and remark in many cases which have come under the observation of every one of us, and the general solution of the problem is embodied in the phrase. "There must be a screw loose somewhere."

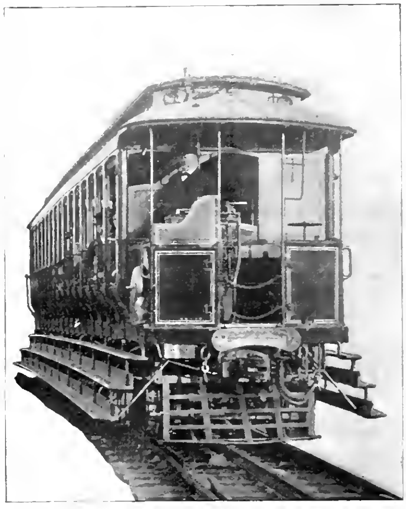
There is probably no grander manifestation of the triumph of mechanical skill than is furnished by a locomotive and its accompanying train dashing along at high speed. You have there the prime mover, the means of generating power as well as the additional components of train and track which unite to form one grand machine. As it passes, the demonstration of a power sufficient to hurl the immense mass, often of more than a thousand tons, at a rate of 60 to 80 feet per second, is truly majestic. The sharp pant of the steam as it escapes from performing its work, the quick vibration of the piston and its attachments, the whirr of wheels, the rumbling and groaning of the truck, the hurricane of displaced air, all combine to make an impressive display of power, and yet the failure of one little detail of the great machine, a loose bolt, or a broken journal, may be sufficient to hurl it from its appointed task, carrying death and destruction in its wake.

It is not proposed, however, to multiply examples of this kind but to take an object lesson from a journal, box, and bearing of an ordinary car, and to follow out in detail its construction and operation, showing the considerations which make and keep it what it is, and the reasons for its simplicity and apparent crudeness. A full consideration of this apparently unimportant detail will throw a strong light on the principles and business considerations underlying all successful mechanical designs. When it is remembered that in a train of 50 cars there are 400 of these boxes, and that the failure of any one to perform its legitimate functions will just as effectively prevent the train from reaching its destination as if the boiler of the locomotive had exploded, an adequate idea of the importance of this somewhat obscure detail can be formed. * * * *

It is not necessary for you to wait until the time for entering on your practical life to utilize the principles here set forth. They apply with equal force to your present studies. In your mathematics, pure and applied, you have formulæ which are the means by which your work is accomplished. A lack of a proper and full understanding of one letter in a given formula may lead to results that will be disastrous as far as your class standing is concerned, and in future may prevent entirely the use of the mechanism which you are now constructing with the aid of your professors, and which you fondly hope will assist you in your future career. It is, therefore, my most earnest advice that you leave no loose screws in the mechanism of your education or you may find it utterly useless when you are in most urgent need of it.

It is my endeavor to show that in apparently simple cases there are often such complications of circumstance and consideration that change from established practice is extremely hazardous and should be entered upon only after the most mature deliberation.

Much of our present practice rests on information that is extremely indefinite so that it is impossible to say how far such



Motor Car for the Hartford-New Britain Electric Line.

practice may be from what is best. But as the result of observations on many abandoned but promising attempts at improvement I would say to you that a change should be entered upon with a great caution.

True scientific humility should characterize the consideration of any question which may arise as to improvement in present practice. The flippant idea that almost any change will be an improvement should be carefully set aside. Novelty possesses no intrinsic merit, although an extended observation of many changes that have been made would seem to teach the contrary.

The crystallized experience of years which forms the foundation of present practice should be regarded with great respect. It forms a ground work resting deep in the obscurity of the past which it is almost impossible to measure or estimate, and it may be much broader and more solid than you are prepared to admit. If you build aside from this foundation you may find that you have builded upon the sand, and the searching effects of practical results may not only bring your fair and fostered structure to destruction but you may, yourself, be ruined in the fall.

In fact your career in starting out in the active pursuit of your profession is very similar to that of a traveler who starts out to traverse a tract of land, rough in contour and covered with ob-

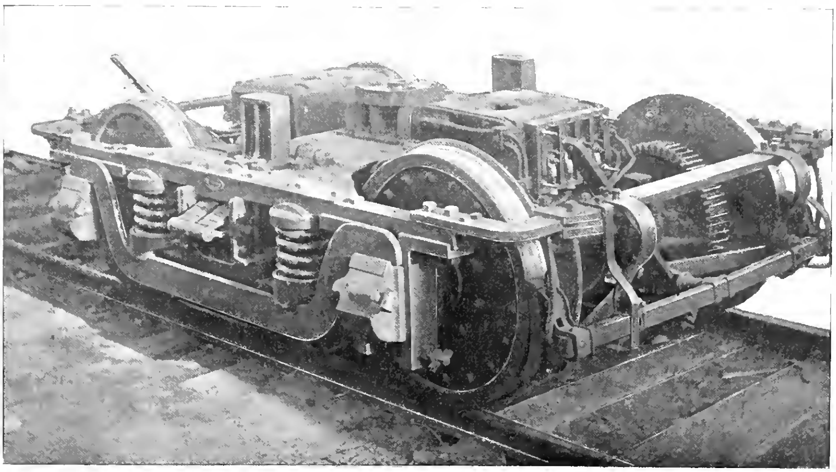
structions. The traveler has been taught certain facts in connection with the ground intervening between him and the point he desires to reach. There are some beaten paths which are tortuous and often steep and difficult. The way seems long and trying. The temptation to turn out of the beaten path and strike into the jungle in the hope of shortening the journey or finding a less laborious way is frequent and pressing. The grief, the trials, the disappointments, the hearthurnings, which have been suffered by those who have broken the present paths, difficult though they be, if known, are forgotten and the young aspirant impatient of his progress breaks aside into the unknown country. This is especially true of the bright, the strong and the active. The patient and persistent plodder is more apt to stay in the beaten path and utilize the labor and experience of his predecessors. In exceptional cases the bold and bright adventurer succeeds, after untold labor and fortunate escapes from danger, in making a new path that strikes the beaten path far ahead and finds himself well advanced toward his goal.

But in the majority of cases the new path is not carried through. The traveler, after struggling through hitherto unknown difficulties, is forced to retrace his steps or emerge from the unbroken country into the beaten path to rearward of the place at which he left it. His more prudent companions are out of sight, and he is compelled to take up his way far behind, carrying with him the pitying thought of his friends that there must be a screw loose somewhere.

Extension of Electrical Equipment on a Surface Steam Railroad.

The electric traction application on the New York, New Haven & Hartford Railroad between Berlin and New Britain on the Hartford Division, and from New Britain to Hartford on the Springfield Division, New England system, was formally tried May 11. This line is 12.3 miles in length, which is the longest road so far changed from steam to electric traction. The portion of the line between Berlin and New Britain is single track, and the portion from New Britain to Hartford is double track, though only one of these, the eastbound, is now operated electrically. Passing turnouts are provided, and cars will run at 20 minute intervals, the fare being 10 cents each way as against 25 cents previously charged on the steam trains.

The third rail system is used, the rail being a flattened " A " section similar to that used on the extension of the Nantasket line. The conducting rail is bonded by ½-inch plates of copper 4½ by 12 inches in size, the conducting capacity of the bonds being about twice that of the rail itself. There are no feeders whatever, the bonding of the rail being depended upon to render additional connections unnecessary. The question of the disposition of the third rail at grade crossings is disposed of by fitting contact shoes to each truck of the second car of every train, with a suitable connection from these to the motors. There is no crossing so wide as to prevent a continuous contact with the rail with this provision, and the rail is omitted in passing all crossings. The conducting rail is carefully protected at the stations and at the New Britain station the rail is cut out from the circuit while trains are standing in the station. The contact with the third rail is made by means of sliding shoes carried by links and suspended beneath the king bolts of the motor car trucks, the distance between the shoes being 33 ft.



Trucks for Motor Cars—Hartford-New Britain Electric Line.

The present length of the power-house, which is at Berlin, is 113 feet 3 inches, its depth is 102 feet 5 inches, and height to ridge pole 65 feet. It is divided by a brick wall into two parts, the part facing the railroad being the engine-room, while the other part contains the boiler equipment.

The boilers are 10 in number, each of 300 horse-power. They are of the return tubular type and are set in two batteries of five each. In the construction of the boiler front a new method, devised by Col. N. H. Heft, Chief of the Electrical Department of the road, who has carried out the entire electrical installation, is followed. The entire boiler front is arranged so as to be taken down without disturbing the rest of the boiler setting, the front being bolted to a plate attached to the dividing wall instead of to the wall itself.

There are two feed-water pumps, either pump being capable of supplying water to both batteries at once. The piping from the boilers is in duplicate and will be covered with non-conductive covering. The flues enter a brick stack 125 feet high, located immediately in the rear of the center of the present building. The coal used is known as locomotive sparks, the burning of which has given considerable satisfaction at the Stamford and Nantasket stations. The coal is taken directly from the tracks in the rear of the station and is emptied into a large bin running along the back of the building.

Power is now furnished by a Greene-Corliss cross-compound condensing engine, built by the Providence Steam Engine Company and rated at 1,200 nominal horse-power, with steam cylinders 28 and 48 inches in diameter by 4-foot stroke. The speed is 100 revolutions a minute. A General Electric standard 10 pole 350 kilowatt generator, of the iron-clad type, is connected directly to the engine. The dynamos are over compounded and furnish current at 600 volts, no load, and 650 volts full load. The shaft and armature weigh 58 tons and the flywheel, which is cast in four sections, and is 18 feet in diameter, weighs 52 tons, mak-

ing a total weight on the bearings of 110 tons. A traveler with two cranes, one of 35 tons, the other of 5 tons capacity, runs the entire length of the engine-room.

The cars five in number are open, as will be seen from the engraving. They weigh 64,000 pounds each and are 50 feet long. Each car has two "G. E. 2,000," motors weighing 4,300 pounds apiece. They were built by the Barney & Smith Car Company, of Dayton, O. The controllers are of the "L" series parallel type, and each car has two automatic circuit breakers. The lighting is by 16 candle-power lamps. Each motor car is fitted with air brakes, two gongs and a chime whistle. Air for the brakes and whistle is furnished by a vertical double cylinder air pump driven by a motor automatically controlled by a special switch which is opened when the pressure in the main tank reaches 90 pounds and closed when it falls below that. The form of the motor trucks may be seen in the second engraving. The General Electric Company kindly furnished the information here presented.

Electricity or Steam in Rapid Transit—Which?

GEORGE MOFFAT.

That the urban and suburban road is the next great field for electricity is claimed by electrical engineers, but as most engineers of all classes are extravagant in their claims, let us see wherein this is substantiated by facts. We find a great deal of interest awakened among railroad men now over this problem, but data for comparison under similar conditions is not obtainable; the results which have been submitted have been presented either by enthusiasts or by over-conservative persons. With Chief Engineer Wallace, of the Illinois Central Railroad Company, stating that the field of electricity in this class of work is limited, and President Clark, of the N. Y., N. H. & H. R. R., quoted as saying that the time has come when locomotives may be consigned to the scrap heap, as coaches were forty years ago, it is impossible for a person not well versed in both sides of the question to come to an intelligent decision—although I would not advise any road to enlarge its scrap heap by dispensing with its engines at the present time, President Clark notwithstanding. And as to the ultimate outcome of this question railroad men are intensely concerned.

We find the "Alley L" in Chicago making the change, and the Illinois Central contemplating it on its Chicago terminal lines, while others are giving it serious attention. Then, again, some of those in charge of roads operating electrically admit that they believe they could operate cheaper with steam. One reason of this may be found in the fact that but very few of our electricians are railroad men, being generally engaged in lighting and street railway work, and not thoroughly understanding the problems and difficulties to be met with and overcome in this special field. Thus many points which are vital are overlooked and neglected, such, for instance, as tractive power. Of course, after once installing a system it is out of the question to make the needed changes which practice shows to the unpractised engineer to be necessary on account of the extra cost, which would more than cancel the saving claimed by adopting the electrical system.

Then, again, an opinion like the following, which is taken from an editorial in *Electrical World* of May 1, does not meet with approbation by railroad men: "The method proposed . . . seems to be a practical suggestion. The efficiency of such a system could not be very high. . . ."

Any system which is of low efficiency is not likely to meet with their approval as being practical. The results obtained by any one road cannot be taken as a basis of calculation for any other road, for these depend chiefly on local conditions and the topography of the city. What would answer in a city like Chicago would be wholly inadequate and unsuitable for one like New York. The claims made by both parties are at times extravagant and over-sanguine. For illustration, the question of repairs, which is an important one, is claimed by each to be in their favor. Mr. O. F. Crosby states that the electrical repair bill should be less than one-third of that for steam locomotives, while the *Railway Master Mechanic* says the cost of motor repairs exceeds that of locomotives. In the writer's own experience on both steam and electric roads, he has found that there is actually very little difference in this respect, and the figures will eventually, he believes, be in favor of motors, as much skilled labor will not be required for repairing them as is at the present time required for steam locomotives, because armature windings are being made on forms, and all repair work is being reduced to such a simple system that a great deal of it may be done by any intelligent laborer after a few days' instruction.

The coal costs about 10 per cent. of the operating expenses on many steam roads; this figure can be cut in two on an electric road which is properly designed. But this result is impossible to attain on a road that has but few transportation units on account of the violently fluctating load, in which there is no economy when operating Corliss engines. It is not necessary to enter into any argument as to how this saving is to be accomplished, for any unprejudiced person can readily see the gain in centralizing power, running condensing engines and having no coal and water load, and many other advantages may be cited, which a little thought will quickly suggest. Economy is paramount in considering any changes. It is first necessary to know whether the money saved by substituting electricity for steam will more than compensate for the additional interest which it is necessary to pay on account of fitting the road electrically. If the manager contemplating the change consults some electrical engineer he will, no doubt, be carried away by the array of figures and "facts" which will be brought forward. Then, if the author of the figures is not a practical railroad man and does not know how to make the road successful, a result will be a disgruntled board of directors, and "Another proof that electricity will not do for railroad work." This is generally caused by carrying street railway practice into railroad work—a mistake, because the conditions are totally different.

The transportation units should have a speed of about 20 miles an hour including all stops. This means it should have the power to attain maximum speed quickly and be able to make stops in the shortest practical time; or, to state it more concisely, we want plenty of starting and stopping power. On this, to a great extent, will depend the capacity of the road, but any increase in the speed will not mean an increase in the carrying capacity; in fact, the reverse is true on account of increased headway essential to safety. We will find the chief objections to the steam road from a public point of view to be noise, dirt and, in congested districts, the inability to ride at times. Will the substitution of electricity improve this? That so far as cleanliness and noiselessness is concerned the verdict is in favor of the motor is disputed by none; and this of itself has a salutary effect on receipts, either in increased patronage or a satisfied public or both. But in stopping and starting there are a number of things which limit and modify the problem which must be considered, such as the weight of cars. The weight of engines on some roads is limited on account of rails being laid on elevated structure. I do not believe that there will be much difference in this respect with the use of electricity, for in order to get strength it may be necessary for electrical reasons to put large slow-speed motors on cars, and this will necessitate the use of larger wheels and probably longer trucks. On account of the design of motors, it will be seen that the "pull" is applied to the whole circumference of the armature instead of being at two points and constantly changing as in steam locomotives. This will favor the electric locomotive in attaining maximum speed in an incredibly short time, but in stopping there will be no difference, as both will be stopped by the same agency--air. In case it become necessary to stop quickly and the direction of motion is reversed, the motor would not be as reliable as the steam locomotive.

It is claimed that with the change, lighter rails may be used; not so, as it needs but a glance at any city street railway to see it has been found necessary to use heavy rails in that service, some being as heavy as 100 pounds to the yard. With a first-class road and good rolling stock the only limit to the motor speed is that determined by the requirements of safety. All of the roads at present equipped have followed the old railroad system,

one motor car with three or more coaches attached, although there is no good reason for so doing. If at least one motor was applied to each car the tractive power would be better, as would the results generally. I am glad to see that Mr. Frank J. Sprague, who advocated this system over ten years ago, will install it on the "Alley L" in Chicago. Such a system does not necessarily entail employing a motorman for each car, as they may all be controlled from the front car. The cars may be uncoupled at any point, and each section controlled independent of the others. Such a system is the ideal for flexibility, although the efficiency of motors will not be as great as one or two large ones would give yet the efficiency of the whole system will be much greater. There is an immense amount of data at the present time, being published in railroad journals, which pretend to show the cost of coal in hauling trains stated as so much per passenger. Such data are trash and not worth considering, as such figures will vary continually with exactly the same mechanical conditions: and are dependent on traffic.

Mr. Geo. S. Strong says, in the *Railroad Gazette* (May 7) that; "The secret of successful competition of steam roads with electrical roads for local and suburban business does not lie in the adoption of electricity, but in the adoption of steam motors that meet all the requirements of an electric motor." If this could be accomplished I would agree with him, but it is a physical impossibility, and the last clause of the sentence is an admission and argument that there is nothing which meets the present requirements of railroad men as does electricity.

To answer the question presented in the title of these lines is to say that the requirements of the public are unquestionably tending in the direction of small and frequent units. They are being educated to this by the competitors of the steam roads and in urban and suburban transportation the steam roads will be compelled to meet this feature of electric railway operation if they are to retain their business. The advantages of electric traction lie chiefly in meeting this problem which cannot be successfully met by the use of direct steam. The roads will undoubtedly be driven to use electric motors and the problem before us is to use them in the proper way. Comparative tests of different systems are needed and if these are made and the effects of different methods of furnishing power are compared, the results will doubtless be toward improvement in the cost of operating by electricity. It is too early to say that electric is more expensive than direct steam traction. No one knows whether it is or is not true. The usual methods of furnishing power in large units for electric work whereby great fluctuations of load cannot be properly accomodated show that there is much yet to be done toward the improvement of existing methods in this direction. I would present the suggestion, that the next road to adopt electricity engage in careful tests for comparative purposes with the object of securing necessary information as to cost and that the application of the electric power should not be complicated with such questionable practices as attempts to heat the cars by electricity. Furthermore the change should not be made with a view of proving the theories of any individual to be correct, but the problem should be worked out with reference merely to the attainment of the desired results in the most satisfactory manner from a commercial standpoint.

Experiments in Boiler Bracing.

One of the subjects treated before the American Society of Mechanical Engineers at the recent Hartford meeting which will specially interest our readers was a description of an elaborate series of tests upon crown stays in a paper by Mr. Francis J. Cole. The paper is an interesting one, but, for lack of space, we present only a few of the illustrations and one of the tables with an abstract of the text as follows:

In all these tests, it is assumed that the bolts are spaced 4 by 4 inches, center to center, supporting an area of 16 square inches.

The total stress which each one would be required to sustain, due to the pressue of the steam, would be the area multiplied by the maximum boiler pressure.

The pocketing or bagging down, which is characteristic of an overheated crown sheet caused by low water, was imitated by using a bearing plate of ½-inch steel 8 by 8 inches square, with a hole 4½ inches in diameter bored through its center. The area of this hole is 15.9 square inches. The specimens were screwed or driven into pieces of ⅜-inch steel plate, 12 by 12 inches square.

A 100,000-pounds Riehle screw testing machine was used, the specimen plate and bolt being inverted, with the bearing plate between it and the head of the machine, the stay bolt hanging down through the middle. Sixteen different styles of crown stays were made, specimens numbered 1 to 16.

These specimens represent the ordinary forms most commonly in use, and other styles which suggested themselves. The material used was 1-inch round mild steel of 58,390 pounds ultimate tensile strength, with an elastic limit of 38,900 pounds, and an elongation of 30.25 per cent. in 8 inches.

The ⅜-inch steel sheets, 12 by 12 inches (a few of the first were 6 by 6 inches) square, into which the bolts were screwed, were mostly cut from one large sheet, having lengthwise an ultimate tensile strength of 59,150 pounds, elastic limit of 28,800 pounds, with an elongation of 31.75 per cent. in 4 inches, and crosswise an ultimate tensile strength of 58,400 pounds, elastic limit of 28,040 pounds, with an elongation of 28 per cent. in 4 inches, both ways showing a silky fracture.

The specimens were heated in a small portable forge, alongside the testing machine. The plates, with the bolts projecting upward, were placed on the fire, and the heat localized in the center over a diameter of about 6 inches, by keeping a small, bright fire, and dampening the outside with fine wet coal, to keep it from spreading.

In this method of heating, the head, or nut, would be hotter than the rest of the sheet, imitating in a measure the conditions which are present in a locomotive firebox. In all the hot tests the sheets were heated to a bright red, but in the first tests owing to the

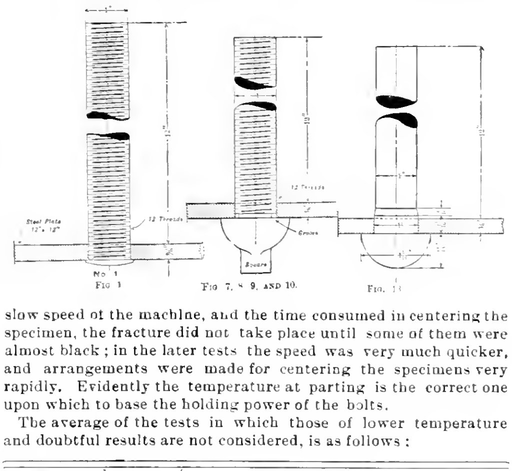


FIG 1. FIG 7, 8, 9, AND 10. FIG. 13

slow speed of the machine, and the time consumed in centering the specimen, the fracture did not take place until some of them were almost black; in the later tests the speed was very much quicker, and arrangements were made for centering the specimens very rapidly. Evidently the temperature at parting is the correct one upon which to base the holding power of the bolts.

The average of the tests in which those of lower temperature and doubtful results are not considered, is as follows:

Spec. No.	Tensile cold.	Strength hot.	REMARKS.
	Pounds.	Pounds.	
1	16,350	3,470	Head ⅛ inch above sheet, riveted just enough to make steam tight; head not to exceed 1⅛-inch diameter.
2	16,700	3,473	Head ⅛-inch above sheet, riveted over.
3	17,600	4,040	Head $\frac{3}{16}$ feet above sheet, riveted over.
4	20,733	4,000	Head ¼ inch above sheet, riveted over.
5	41,950		⅞-inch std. nut tapped out to 1 inch, 12 threads, and riveted over; project about $\frac{1}{16}$ inch to ⅛ inch.
6	42,000	6,000	1-inch std. nut, 12 threads, riveted over; projects about $\frac{1}{16}$ inch to ⅛ inch.
7	38,120	7,095	Button head, ¾-inch groove.
8	39,800	6,933	Button head, $\frac{13}{16}$-inch groove.
9		7,500	Button head ⅞-inch groove.
10	39,800	7,483	Button head, $\frac{15}{16}$-inch groove.
11	39,800	8,766	Button head, no groove, countersunk.
12	42,580	9,333	Button head, no groove, $\frac{3}{16}$-inch copper washer.
13	43,100	10,150	Button head, with $1\frac{1}{16}$-inch reamed hole.
14	39,720	7,816	1-inch std. nut, 12 threads, nut countersunk ¼-inch and well riveted over.
15	24,000	4,613	Screwed in sheet, 12 threads, rivet head ⅜-inch high and ½-inch diameter; largest head which can be formed.
16	40,300	9,730	Button head, with 1¼-inch tapered reamed hole, 3-inch thimble and nut.

Regarding the holding power of stay bolts screwed through [illegible]-inch plate and riveted over, as shown in specimens 1 to 4 and 15, it will be observed that the average holding power when cold is 16,350 pounds for the worst, and 24,000 pounds for the best, and when hot, 3,470 pounds for the worst and 4,613 pounds for the best. This would indicate that the best riveted head which can be formed cold, made in the usual conical shape, has a holding power, hot and cold, very much less than the worst form of bolt with solid head, even when nicked or grooved deeply under the head, or bolt screwed through with a nut on under side of sheet.

It does not appear that the solid button head bolts are deficient in holding power when tested in this manner, but the principal objection to their use is the liability of injury when screwed into a firebox where the holes are not tapped at right angles to the sheet, and where the surface of the sheet is curved. This objection can easily be removed by properly seating the head. It is the regular practice of the locomotive company, with which the writer is connected, to use a seating tool, which faces off the under side of the sheet exactly at right angles to the longitudinal axis of the bolt. This not only insures a much tighter fit, but guarantees absolutely against any bending of the head, when screwing it close up to the crown sheet.

The holding power of the staybolt, when provided with a nut, is considerably increased when redhot by countersinking the nut and well riveting the bolt into the same, as shown in specimen No. 14.

The characteristic failure of the bolts when screwed through and riveted over was by the sheet bagging down, stretching out the

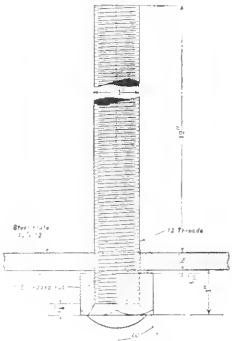


Fig. 14.

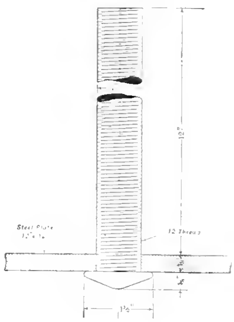


Fig. 15.

threads to a bell-mouth shape, and shearing off a small annular ring representing the thickness of the riveting. It will be observed, when referring to specimens 1 to 4 and 15, that the edges of the head are very shallow where they are sheared off in line with the edge of hole, and that the holes are stretched to such an extent that the threads lost their holding power. Generally speaking, the use of a nut increases the holding power of the staybolt over the plain riveting, when tested cold, about 100 per cent, and 50 per cent. when heated to a bright red.

One of the most noticeable features shown in these tests is the comparatively slight decrease in holding power of any of the forms of crown stays until a temperature exceeding a black or dull red has been reached. This is especially so in the case of test No. 14, specimen No. 1, which, at a dull red, showed a strength of 14,800 pounds, and the average strength of the same, cold, was 16,350 pounds. The results of the tests would seem to support the statement that the average holding power of the usual form of staybolt at a dull red or almost black heat would be decreased from its strength cold about 50 per cent., and at a bright red, decreased to about one-fifth of its original strength, except in specimens 11, 12, 13, and 16, which are decreased to about one-fourth of their original strength. In the case of specimens 13 and 16, their holding power would be very much increased by the use of a thicker crown sheet, as they mostly failed, both hot and cold, by the head pulling through the sheet.

The conclusions of the writer are:

That the center rows (5 to 10, according to the size of boiler) of the crown stays should be provided with solid button heads, or with nuts like No. 14, to prevent pulling through in case the crown sheet is overheated.

Grooving or cutting out the first thread under the head should be avoided. It not only weakens the bolt in its most vital poin but the possibility exists that some bolts are liable to be cut deeper than necessary by careless workmen. Moreover, it is unnecessary, as tighter work can be done by slightly countersinking the sheet.

It is good practice to enlarge the end screwed in the crown sheet for 1 inch or $1\frac{1}{4}$ inches directly under the button head, making it slightly taper. For 1-inch round crown stays a good proportion is to upset the lower end for $1\frac{5}{32}$ inch or $1\frac{3}{16}$-inch thread, leaving the upper end for 1-inch thread. For $1\frac{1}{8}$-inch round stays, lower end $1\frac{9}{32}$ inches, or $1\frac{5}{16}$ inches upper end, for $1\frac{1}{8}$ inch thread.

The argument often advanced, that it is safer in radial stay boilers to omit all heads or nuts on firebox ends of crown stays and allow a few to pull through easily in case of low water so as to put out the fire and relieve the pressure, does not seem to hold good in practice, as the sudden letting go of a few bolts throws such an additional load on the adjacent ones, that they are frequently unable to stand the strain and tear out row by row until the whole crown is blown down.

As crown sheets are usually higher in front than behind and arched in the center in radial stay boilers, good practice indicates that a few crown stays (say 10 or 12) in the front and in the center —the highest point—should be left without heads or nuts, and simply riveted over. In case of low water these would pull out and relieve the pressure, before the rest gave way. A prominent railroad having this in view, leaves every other crown stay riveted over without solid button head or nut.

It is better to face the sheet with a cutter, allowing the solid finished metal surfaces to come together without twisting or bending the crown stay, than to use a copper washer or to bend the bolt under the head in attempting to tighten it up against a rough, uneven surface.

A Good Route to the Conventions.

The Pennsylvania Railroad, by its "Cape Charles Route," offers the most convenient and rapid way of getting from New York and Philadelphia to Old Point Comfort by rail, on trains leaving New York at 7:55 a. m. and 7:55 p. m., arriving at Old Point Comfort at 7:05 p. m. and 8:00 a. m. respectively. These trains have Pullman buffet parlor and vestibule sleeping cars running to Cape Charles. Returning, the trains leave Old Point Comfort at 8:40 a. m. and 7:10 p. m., arriving in New York at 8:45 p. m. and 8:00 a. m., respectively. The night trains run daily and the day trains on week days only.

Lead for Locomotive Valves.

The important subject of lead for locomotives has been brought into prominence again by the paper recently read before the Western Railway Club by Mr. C. H. Quereau, in which it was clearly demonstrated that the general tendency is toward reduced lead, with very good reasons for the practice. In this connection, a paper published some time ago in the *Organ fur die Fortschritte des Eisenbahnwesens* by Mr. August von Borries, Inspector of the Hanover State Railways, is of special interest. This has been translated for these columns, and, while it is not brief, it is presented nearly in full on account of the value of the statements which are made by this authority. It will be noticed that Mr. von Borries' experience dates back to 1878, and that the facts stated are in accordance with conclusions drawn by Mr. Quereau. It is understood that with compound locomotives Mr. von Borries uses only 0.08 inch lead on the high-pressure cylinder and only 0.03-inch on the low pressure, and that his results are entirely satisfactory.

In consideration of the great influence which the valve motion has upon the consumption of coal, and the hauling power of the locomotive, I have taken it upon myself to add my own experience to that of Messrs. Straufs and Richter. This experience is not confined to the valve motion upon any single locomotive or type of locomotive, but is based upon about 16 years of observation on more that 400 locomotives, and is in accord with that of many establishments as well as the investigations of engines in service. This experience should therefore be of especial value, in that it has led to the formulating of simple rules for the determination of the dimensions of valve motions, and enables us to explain in a very simple fashion the favorable results that were obtained in the experiments of Straufs and Richter.

In the year 1876 a special provision was made in a new six-wheeled fast passenger locomotive that was built with an Allen valve motion and crossed eccentric rods, to increase the outside lap by 0.04 inch, and the lead which had previously been from 0.11 inch to 0.15 at 0.2 cut-off was thus reduced to from .07 inch to .11 inch. All of the locomotives treated in this way showed themselves to be superior to the old locomotive of the same construction in every way. The same thing was first shown in 1878 on a standard passenger locomotive, which originally had from 0.11 inch to 0.15 lead at 0.2 cut-off and worked in a loggy manner, but by increasing the outside lap

by .04 inch the machine worked very freely. A further increase of the lap produced a decrease in the efficiency, even when working in full gear.

A still more remarkable result was first obtained in 1880 on a standard freight locomotives which, at 0.3 cut off, and with Allen valve, had a linear lead of from 0.15 inch to 0.2 inch, and in spite of the remarkable increase of efficiency it did not exceed in any of the principal dimensions those of the old freight engines, although it did burn somewhat more coal than they did. In this case the outside lap was increased about 0.08 inch, and since that time has done better work than the standard locomotives.

These results gave occasion to test the valve motions of all of the old passenger and freight locomotives on the Hanover railways. In many cases the lead was found to have been 0.32 inch, the decrease of which, according to the size of the valve, being from 0.11 inch to 0.15 inch for plain valves, has invariably made an improvement in the working of the engine.

At a later period there was an opportunity of substantiating the accuracy of the first observations. For example, the efficiency of a freight locomotive built for short runs with a large boiler and standard working parts was a little less than that of the standard engine, but was made to surpass the latter after its lap, which was originally 0.79 inch, had been increased to 0.87 inch. In one of the later arrangements of the compound freight locomotives the previous unsatisfactory action of the type was discovered and the reason therefor found to lie in the fact of a defective valve motion which gave a lead of from 0.12 inch to 0.16 inch, instead of from 0.08 inch to 0.12 inch. It may be remarked that it is the Allan valve motion with crossed rods which is used almost without exception and that it is designed with good proportions; that there are no essential differences in any of the standard locomotives, and that the clearance space averages about ten per cent. of the space swept through by the piston. The inside lap runs from 0.04 inch to 0.08 inch and variations of 0.04 inch in either direction have but very little influence upon the running of the engines.

Hereafter, with a cut-off of from 0.2 to 0.3, the lead was made from 0.08 inch to 0.12 inch for Allen valves and from 0.12 inch to 0.16 inch for plain valves, while an inside lap of from 0.04 inch to 0.08 inch has generally given very satisfactory results, and these proportions have been made a fixed rule in all of the shops, and every valve that is brought in for repairs is changed so as to coincide with them. A variation in the action of the valve necessarily follows, on account of the well-known irregularity due to the use of the link motion, wherein the forward lead is about 0.04 inch greater than it is at the back.

It was only upon the adoption of these standard dimensions that the same efficiency was obtained in all locomotives of the same construction. Hence it was essential that there should be an entry made in the workshop books, in which every improvement made in the locomotives brought in for repairs should be recorded in accordance with the following form:

LOCOMOTIVE NO. 1.266.

	Left.		Right.	
	Front.	Back.	Front.	Back.
1. Lead.				
Forward (full gear)....	.14 inch	.12 inch	.14 inch	.10 inch
0.2 cut-off	.10 inch	.08 inch	.10 inch	.08 inch
0.2 " (backing)....	.10 inch	.08 inch	.08 inch	.08 inch
Full gear "	.12 inch	.10 inch	.14 inch	.14 inch
2. Piston stroke.				
For 0.2 cut-off forward	7.27 inch	7.5 inch	4.13 inch	4.33 inch
Backwards the same	....	....	....	....
3. Clearance.				
Pistons	11 per cent.	11 per cent.	10 per cent.	10 per cent.

The figures given in this table are from a compound freight locomotive. The question then naturally arises:

On what does the great influence of the lead depend for effecting an improvement in the action of the steam and how can it be explained that so little has been learned in regard to it up to the present time?

The explanation of the first portion of the question is comparatively simple: If the steam admission line begins too soon before the crank reaches the dead point, the full pressure upon the piston will also be reached too early, with the result that a corresponding pressure is exerted upon the crank pins and axle boxes, which creates a very considerable frictional resistance, and also imposes a detrimental amount of work upon the pistons during the forward motion. The relation of friction to useless work will also be an unfavorable one, in that it will tend to make the running of the engine loggy. If, on the other hand, the admission is made too late, the necessary steam pressure will not be reached before the point of cut-off, especially at high speeds. The locomotive then runs very easily, but is deficient in power.

For the determination of the most suitable dimensions for the width of the lead opening, the ordinary indicator cards give almost no assistance, since they do not mark the forward motion in the neighborhood of the dead points, or the internal frictional resistance of the machine. These mistakes are frequently made through an imperfect understanding of the case, since good admission lines can always be obtained by increasing the lead. As illustrating this statement it may be said that the first standard freight locomotive with an Allen valve and a large lead gave faultless admission lines, while the older and better-working locomotives with the common valves gave cards with the admission line falling off very decidedly.

The inadequateness of the indicator lines to furnish sufficient data for the determination of a satisfactory valve motion must be taken as the answer to the second portion of the question. It is, therefore, necessary to guard against accepting an indicator card as an evidence of the good action of the steam and the satisfactory operation of the valve motion. In this matter we must rely upon practical investigation alone in order to obtain trustworthy information.

That the width of the lead opening is a matter of very great importance will be clear, if we consider, that, as it is increased, the lead angle increases at the same time, and the entering stream of steam will also be increased in two directions.

In Fig. 1 the valve motion of the standard freight locomotive is shown in twice its natural size for a cut-off at one-quarter stroke, in the valve circle II., for an outside lap of 0.79-inch and 0.16-inch lead and in II., II. for a lap of 0.87 and a lead of 0.08 inch. We see that the angle of opening *BOd* in case I. is twice as much as it is in case II. The triangle enclosed by the lap circle, the valve circle and the line *OB*, which we may call the lead surface, is at least four times as large in case I. as in case II. We must then acknowledge that the action of the lead on the entering steam varies almost as the square of its width. Hence its very marked importance.

In a further consideration of Fig. 1, it is necessary that the following points should be taken into account in order to correctly understand it. For a given outside lap, the valve circle is definitely fixed by the lead (the intersection with *AOB*, the point of cut-off in the line *Oa* and the center *O*, on the principle of three points determining a circle. When the inside lap is also known the whole circle of steam distribution is determined for every point of cut-off, as has also been shown by Richter. As the link motion must be so designed as to produce this valve circles, it is next in importance. From a comparison of the two valve circle I. and II., all of the variations in the action of the steam can be deduced therefrom without further trouble. By diminishing the lead opening to that shown in II., the following changes are made in the original valve motion I.: (1) The maximum opening in the admission line is somewhat lessened; the cut-off at *Oa*, takes place somewhat more slowly. (2) The expansion will be prolonged from b_1 to b'_1, since the

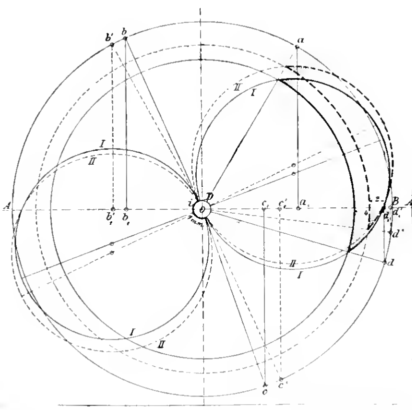


Fig 1

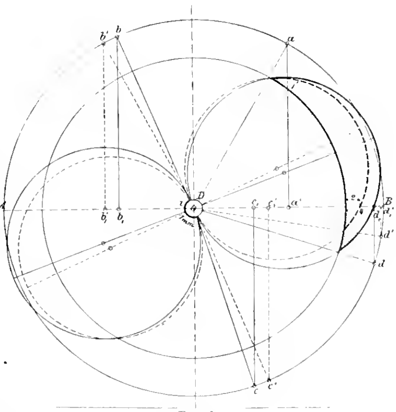


Fig 2

Lead for Locomotive Valves.

exhaust takes place at *Ob* instead of at *Ob*: (3), the exhaust is also somewhat prolonged at C_1 C'_1 and the compression consequently shortened, since the valve closes at *Oc* instead of at *Oc*.

The slight decrease in the admission opening is devoid of any serious detriment to the operation of the engine, while the increase of about three per cent. in the stroke of the piston during expansion is a slight advantage and the increase in the exhaut line by about four per cent. is of considerable advantage since the back pressure is in this way diminished, and the internal friction is lowered by the decrease in the pre-admission. Since the valve circle II. may be wholly derived therefrom, it might be concluded that the valve motion for the portion indicated by (1) might be given a slight forward motion or that the advantage indicated under (2) and (3) could be obtained without any special changes other than an increase of the outside lap.

But if we wish to retain the present steam valve, it is possible to secure the diminution of the lead with all of the results that have been mentioned, as shown in Fig. 2, by lessening the throw of the valve; the latter can be obtained in the simplest way by decreasing the angular advance of the eccentric; a method that is hardly to be recommended in that the whole admission and exhaust opening will be thereby diminished.

The deductions obtained from the two figures hold good, not only for a single case, but for all poi ts of cut-off. In determining the dimensions of the lead opening, both for the Allen and Stephenson valves, it is necessary to consider what changes should be made in it so as to secure the most efficient action of the steam at that point of cut-off which is most in use. The size of the lead opening in the valve motion, as laid out, is without any essential influence provided the full gear cut off is at least 75 per cent. of the stroke, whereby the locomotive can be advantageously worked in that position. In this connection it must be borne in mind, that by an increase of the outside lap as shown in Fig. 1 the full gear point of cut-off is somewhat shortened.

The results of the first of Straufs' observations and of Richter's experiments are therefore in accord with my own experience. That the diminution of the lead opening, brought about by these two gentlemen by twisting the position of the eccentrics, can be accomplished in my way by an increase of the outside lap, is a matter of no importance, since this depends less upon the effective action of the steam than on the slight change in the point of cut-off. For the latter the size of the lead opening is usually a matter of less importance, since the lead angle is always small. Since the full gear is always used at low speeds, it will be advantageous to use a small lead of from 0.04 inches to 0.08 inches for that point of cut-off. A well-designed valve motion should therefore give a lead of from 0.04 inch to 0.08 inch for full gear with an Allen valve, and from .08 inch to .12 inch for a short cut-off, which values can only be obtained with the Allen gearing when open eccentric roads are used. An Allen valve motion, with crossed rods, must be set askew for this purpose, but in the Heusinger and Gooch movements, no especial advantage is obtained thereby, if the lead is properly proportioned. In the Stephenson motion the variation of the lead is about three times as great as in the case of the Allen type, hence for mid-gear, with open rods, it will be from 0.12 inch to 0.2 inch greater (with cross rods a little less) than for full gear. In order, then, to obtain the above mentioned values, it is necessary when considering the use of open rods from the standpoint of Herr Richter, to give the forward eccentric a greater angular advance than the backing, whereby the lead opening for the backward motion entirely disappears at a cut-off of about 0.3. In many of the compound locomotives built in England with the Stephenson valve motion and open rods I have therefore preferred to give almost no lead for full gear with the same angular advance for both eccentrics. Then at 0.6 cut-off this becomes about 0.04 inch, and at 0.3 it reaches about 0.12 inch. This design of valve motion has given a very good account of itself in spite of the great hesitation manifested by the builders in accepting it.

It must be remarked in this connection, that the ineffective results obtained with many compound locomotives is due to the dimensions of the lead opening. Since compound locomotives must work with a cut-off of at least 0.3, there is always an opening of considerable width into the ports, and as the compression of the steam at the end of the stroke is considerable, it is unnecessary that, for the attainment of full pressure at the commencement of the stroke, these locomotives should have a wide lead opening. And this may preferably be placed at from 0.04 to 0.08 inch.

If in the well-known work of Auchincloss-Muller a considerably wider lead opening is indicated as being essential, it must be remembered, that at that time Allen valves were not in common use in America, that by the use of rocker shafts there is some lost motion, which diminishes the lead and that finally the Americans had not, at that time, fully realized the necessity for an economical use of fuel.

EQUIPMENT AND MANUFACTURING NOTES.

The Chicago, Milwaukee & St. Paul will build 200 coal cars at its West Milwaukee shops.

It is stated that President Diaz, of Mexico, has ordered a private car of the Pullmans, to cost $40,000.

The Cooke Locomotive and Machine Company has received an order for two locomotives for Japan.

The Baltimore & Ohio has placed an order for 25 locomotives with the Baldwin Locomotive Works.

The Rogers Locomotive Works has received an order for 15 ten-wheel locomotives from the Mobile & Ohio R. R.

Six locomotives have been ordered of the Baldwin Locomotive Works for the government railroads of South Africa.

The New Orleans & Northwestern Railroad has ordered a locomotive of the Richmond Locomotive & Machine Works.

Henry L. Leach, of North Cambridge, Mass., reports sales during the month of April of 153 sets of the Leach sander for locomotives.

The Brooks Locomotive Works has received a cable order from Shanghai, China, for three standard gage, side tank passenger locomotives.

The Brooks Locomotive Works will build the boilers for six engines for the C., R. I & P. Ry. The engines are to be erected at the shops in Chicago.

The Baltimore & Ohio Railroad is still adding to its equipment. Its latest reported order is for 500 coal cars from the Michigan-Peninsular Car Company.

Mr. L. Oberauer has resigned his position with the United States Car Company to accept that of mechanical engineer of the Schoen Pressed Steel Company, of Pittsburgh, Pa.

Mr. W. E. Clark, of No. 8 Oliver street, Boston, has been appointed the New England representative of the Standard Steel Works, for the sale of tires and steel-tired wheels.

The wheels for the 600 steel cars for the Pittsburgh, Bessemer & Lake Erie will be made by the New York Car Wheel Company, of Buffalo, N. Y. They are to weigh 700 pounds each. The Carnegie Company will make the axles.

The new addition to the plant of the Schoen Pressed Steel Company, at Allegheny, Pa., has been completed. It covers about five acres of ground, and includes nine large cranes, two lathes, a boring machine and a wheel press.

The Fox Solid Pressed Steel Company, of Joliet, Ill, and the Fox Pressed Steel Company, of Pittsburgh, Pa., have been absorbed by the Fox Pressed Steel Equipment Company, with offices in the Havemeyer Building, 26 Cortlandt street, New York City.

The Cloud Steel Truck Company, of Chicago, Ill., has just been incorporated by Messrs. C. L. Sullivan, W. J. Dickenson, E. W. Rosenberg, W. E. Smith and Willard A. Smith. The capital is $600,000 and the company will manufacture and sell railroad materials.

One thousand box cars, stenciled "B & O.—Fairport Line," have been built for service between Fairport and points east and an order has been issued that these cars shall be used exclusively in this line and in connection with the new Great Northern-B. & O. trans-continental traffic agreement.

H. K. Porter & Company, Pittsburgh, have closed a contract with the Russian government to supply locomotives to be used on a new railroad in Finland. The order is for two locomotives of the light passenger class. They are of 29½-inch gage, and will be the first narrow-gage passenger engines to be placed in Finland.

The Rand Drill Company has received an order for the ninth compressor from the A., T. & S. F. Railway Company. The compressor is duplex with compound air cylinders and inter-cooler. The company has also received an order from the Alabama Gold Belt Mining Company for an air compressor, and also an order for another from Peru, Ill.

The Chicago, Burlington & Quincy has begun to rebuild its car shops at Plattsmouth, Neb., which were burned last winter. The new buildings will be the same size as ths old ones, but will be built of brick, with iron framing. Parts of the old buildinga which were not totally destroyed will be used. It is expected that the work will be completed before September 1.

The Baltimore & Ohio Railroad Company has arranged with Pullman's Palace Car Company for a new equipment of observation parlor cars for use during the summer months between Pittsburgh and Washington and Wheeling and Washington. These cars are new and will be the first of this style to be used on the mountain divisions of the Baltimore & Ohio Railroad.

The Canadian Pacific is about to commence the building of 21 locomotives at its Hochelaga shops. Five first-class passenger coaches, together with baggage, express and smoking-cars will also be built for use on the Toronto, Hamilton & Buffalo section. At Perth, Ont., 100 refrigerator, 10 furniture and 60 dump cars are now under construction at the company's works.

The Facer Solid Steel Car Wheel Company has turned out at its works at Perth, Ont., a car wheel made from a solid steel ingot by a process invented by James A. Facer. About two years ago a similar wheel was made by Mr. Facer at Lewiston, Pa., and was exhibited at the annual conventions of the Master Car Builders' and Master Mechanics' associations at Alexandria Bay in June, 1895.

The Westinghouse Electric & Manufacturing Company of Pittsburgh, Pa., will have very complete exhibits of its various lines of electrical equipment at the coming annual convention of the National Electric Light Association, to be held at Niagara Falls, N. Y., on June 7, 8 and 9. Representatives of the concern will also be present from its Pittsburgh, Philadelphia, New York and other branch offices.

J. W. Duntley, President of the Chicago Pneumatic Tool Company, 635 Monadnock Block, Chicago, sailed for Europe May 19. He will visit England, Scotland, France, Russia, Austria, Germany, Norway and Sweden for the purpose of extending the foreign business of the company in pneumatic tools and machinery. The foreign business of the company is increasing and the works have been doubled in capacity to keep pace with that and the demand at home.

The Savannah (Ga.) Locomotive Works and Supply Company has been incorporated by John J. McDonough, Thomas Ballantyne, W. C. McDonough, P. J. O'Connor and M. A. O'Bryne. The company is authorized to do a general business in building, repairing and leasing locomotives and to manufacture and deal in railroad material and supplies. This company built a plant during 1896, and from the present action it is to be supposed that operations will soon commence.

We are informed that on May 6 the United States Circuit Court sitting at St. Louis rendered a decision in the case of the Westinghouse Air Brake Company against the Lansberg Brake Company, of St. Louis. The suit was for infringement of the Westinghouse patent March 28, 1887. The decision was in favor of Westinghouse, and a perpetual injunction was issued against the Lansberg Company, restraining it from using its device during the life of the Westinghouse patent.

A large shipment of army coast defense cannon was recently made from the Watervliet arsenal near Troy, N. Y., to the Sandy Hook proving grounds. The shipment comprised 46 guns, as follows: Fifteen 8-inch rifles of 32,480 pounds each, nineteen 10-inch rifles of 67,200 pounds each, and twelve 12-inch rifles of 116,480 pounds each. The total weight of these guns is considerably over 3,000,000 pounds, and their total value or actual cost is about a million and a half dollars.

Among the large orders recently shipped by the Connellsville Car and Machine Company, of Connellsville, were 50 mine cars for the Washington Coal and Coke Company, at Stickel Hollow; 20 mine cars and two larries for the Cambria Iron Company; one larry each for the McCleary Coke Company and the Connellsville Coke Company; a pump and a number of mine cars for the West Newton Coal and Coke Company; and a large pump for the Cresson and Clearfield Coal and Coke Company, of Clearfield County.

A patent has recently been issued to F. D. Gildersleeve, of St. Louis, Mo., for an arrangement of an express car for the purpose of protection against robbery. The car is fitted with a grating of flat steel bars, the openings through which, for ingress and egress, are controlled by the messenger. If robbery is not to be stopped by action due to aroused public sentiment some such protection would appear to be desirable. The patent is for sale by Mr. Gildersleeve, who is in the passenger department of the B. & O. Railroad at St. Louis.

The Dickson Manufacturing Company of Scranton, Pa., reports good business in all departments. They are building a boiler shop addition to their works that will give them a capacity of 150 engines per year. The Midvale Steel Company has given an order to this firm for a switch engine with 12 by 18 inch cylinders. The company is also building a compressed air locomotive for the Delaware & Hudson coal department, with cylinders 9 by 16 inches; also a mogul engine for the same company, with 10 by 16 cylinders, and an unusually wide firebox for burning culm.

The Chicago, Burlington & Quincy Railroad has recently turned out the Aurora shops two complete trains of the latest design for service between Chicago and Kansas City. Each train will consist of baggage, mail and smoking-car, two reclining chair cars, one dining-car and two sleepers. All the cars have wide vestibules and other improved appliances for the safety and comfort of the passengers, and the train is illuminated throughout by the Pintsch light, which has achieved an enviable record for efficiency, safety and economy. The inside decorations and furnishings are of the most unique and handsome designs.

The business of the Bushnell Manufacturing Company, of Easton Pa., is in a very satisfactory condition judging from a list of orders recently taken. Among these are seats for 10 passenger cars, which are being built by the St. Charles Car Company for the Florence & Cripple Creek Railroad; 400 seats for the Milwaukee Street Railway Company; the seats for four cars for the Philadelphia & Reading Railroad; seats for 50 cars for the Louisville Traction Company, and several small orders of one or two cars each, among them being the seats for a funeral car which the Central Railroad of New Jersey is building at its Elizabethport shops.

According to a note in the New York *Herald*, English railroads cannot be compelled to purchase their rolling stock in England. Recently Mr. C. T. Ritchie, President of the Board of Trade, replying to Sir Charles Howard Vincent, member for the central division of Sheffield, said, in the House of Commons, that the government was not prepared to compel companies applying for new railway charters to buy their equipment in the United Kingdom. In the case of the Waterloo City Railway, Mr. Ritchie added, 22 cars had been ordered in America, because of the seven English firms tendering for the work not one of them was able to deliver the stock in the time required by the railroad company.

The suit brought by the Consolidated Safety Valve Company vs. the Ashton Valve Company in the United States Circuit Court, for an injunction to restrain the defendants from the alleged infringement of a patent for steam safety valves, granted January 19, 1869, to George W. Richardson, according to the Boston Herald, was dismissed by Judge Colt. The Court held that the proper construction of the Richardson patent requires that the aperture at the ground joint caused by lifting the valve should always be greater than the aperture for the exit of steam into the open air. The defendants' valve does not embody this construction, and the Court holds that it does not infringe upon the plaintiff's patent.

The Baltimore & Ohio Railroad Company has secured possession of dock property at Chicago and Milwaukee for the new lake line from Fairport. One of the Milwaukee docks is at 50 West Water street, and has a corrugated iron warehouse 300 by 200 feet, with wide entrances for teams and a railroad track running its entire length. There is another dock on the Menominee River that has a slate-covered warehouse 325 by 60 feet. Both docks will be used for receiving and forwarding freight. The Chicago dock is at the foot of Illinois street and has a 200-foot frontage on the river and runs back to Illinois street. It is estimated that it has a storage capacity of about 3,000 tons, and it is fully equipped with railway tracks.

The Peerless Rubber Manufacturing Company states that much annoyance has been occasioned by misrepresentations having been made as to the founding of the company and the manufacture of its goods. It is desired that it should be distinctly understood that the company was formed in 1872 by Charles Foster, Jr., and Henry S. Winans, who associated themselves with John H. Deming as Superintendent, who has been with the company ever since and who is now its General Superintendent. An experience of 34 years and the knowledge of the process of manufacture followed by that concern, some of which he alone understands, should entitle him to a high place among manufacturers of these goods. He is the only man who has been employed as Superintendent by that company.

It is stated that the 15 ten-wheel freight engines which the Rogers Locomotive Company are building for the Mobile & Ohio Railroad will each weigh in working order about 124,500 pounds. They will have cylinders 18 by 26 inches, and driving wheels 56 inches in diameter, with 48-inch cast-iron centers. The specifications call for Richardson balanced slide valves, Latrobe steel tires, Carbon steel for boilers and fireboxes, 180 pounds working pressure, New York Air Brake Company's brakes, Ajax bearings, United States metallic packing, National hollow brake beams, Ashton safety valves, Nathan lubricators, Crosby gages, Monitor injectors, Buck-Handlan headlights, Leach sanding apparatus and Gould couplers. The boilers will be 60 inches in diameter at the smallest ring, the fireboxes will be 108⅛ inches long, 33¾ inches wide, 72 and 64 inches deep. There will be 248 two-inch tubes, and the total heating surface will be 1,844 square feet.

Mr. A. Thompson has been investigating the operation of the Hardie air motor on the 125th street line in New York for Sir A. B. Foxwood, one of the chief owners of the city railways in Liverpool, England, and in his report he says: "Looking at this system from a mechanical point of view, there appears to be no doubt of its efficiency. The details connected with the service which we examined have been very carefully wrought out and constructed, and the machinery appeared to have sustained no wear and tear of any moment after continuous service of about eight months. The arrangement of the machinery in the car is that of a plain simple engine, the working parts are of good strong section and design, and should last for a long time with a very little upkeep, and we have no hesitation in stating that a plant fitted upon this system, with the arrangements and details carried out properly to begin with, would work with as great or greater efficiency and more economy than any other system which we are acquainted with."

The adoption of the Pintsch light by the B. & O. R R. necessitated the erection of additional Pintsch gas plants for the purpose of supplying the cars. New plants have been constructed and are now in operation at Baltimore, Washington and Pittsburgh, and all recent improvements in the construction and design of the special machinery required for the production of the gas have been incorporated. There are also plants at Cincinnati, St. Louis, Chicago, Cleveland, Indianapolis and Columbus, O., so that the entire B. & O. and B. & O. S. W. system can easily obtain a supply of Pintsch gas for the cars, which are now equipped with the new light. The Pintsch light is now used by railroads the world over, and at present there are over 85,000 cars equipped with the system in this country and abroad. In order to fully supply the large number of cars with gas, over 45 Pintsch plants are now in operation in various parts of the country, extending from the Atlantic to the Pacific oceans, and from the lakes to the gulf, and new plants are being constructed as occasion requires.

Mr. John B. Hicks, who has filled the position of manager in the United States for Robert Ingham Clark & Company, Ltd., of London, Paris and Hamburg, manufacturers of fine varnishes, has been appointed manager of the railway department of the company, under the reorganization which has recently taken place with the Pratt & Lambert Company. The offices of the company are in the Woodbridge Building, corner of William and John streets, New York. It is announced that the Pratt & Lambert Company has reorganized with an increase of capital of $350,000, of which the controlling interest has been taken by Robert Ingham Clark & Company, Ltd., of London, Paris and Hamburg, whose paid-up capital is $1,500,000. It is the purpose of the combination to add to the line of common varnishes made by Pratt & Lambert the high grade finishing varnishes made by the English concern, whose trade marks and brands will be controlled in the United States and Mexico by the American house. Robert Ingham Clark & Company have always made the best class of goods exclusively, and have for years held the trade of such large consumers as the British Admiralty, the Indian Government, the London General Omnibus Company and several British railway lines. The new officers of Pratt & Lambert are A. C. Bedford, representing the Pratt interests, President; Robert Ingham Clark, Vice-President; W. H. Andrews, Treasurer and Managing Director; Charles Pratt and S. N. Griffith, the latter of the R. I. Clark Company, Directors. There will be no change in the personnel of the management here.

The Northern Pacific Railway has recently published an attractive pamphlet, entitled "Wonderland '97," from the pen of O. D. Wheeler. This is the annual "Wonderland" publication of the road, and while they all treat of one general subject they are free from repetition. The author takes up the territory covered in a trip of several weeks over the road and each year presents a new portion in this pleasing form. The work is divided into four chapters. The first is entitled "The Great Northwest," and treats of the history and the geography of that region. The Yellowstone Park is the subject of the second, and some beauties of that always interesting place are mentioned which are not usually noticed in detail. "Go Make Money" is the title of a chapter concerning mines and mining, and "The Heart of the Olympics" treats of a new and beautiful section brought to the tourist's attention for the first time. Copies of the pamphlet will be sent to applicants who enclose six cents in stamps to Mr. Chas. S. Fee, General Passenger and Ticket Agent of the road at St. Paul, Minn. These publications are increasing in usefulness and in attractiveness. The letterpress and illustrations are excellent, and as a matter of general information concerning the territory covered by the road the pamphlet will amply repay the trouble required to obtain it. It is rn interesting publication.

Our Directory

OF OFFICIAL CHANGES IN MAY.

We note the following changes of officers since our last issue. Information relative to such changes is solicited.

Atchison, Topeka & Santa Fe.—Mr. Wm. Renziehausen has been appointed Assistant Master Mechanic at Ft. Madison, Ia.

Baltimore & Ohio Southwestern.—Mr. T. G. Duncan has resigned as Assistant Master Mechanic at Chillicothe and is succeeded by Mr. John Hair.

Baltimore, Chesapeake & Atlantic.—Mr. J. S. Wilson has been elected President to succeed Mr. J. E. Searles, resigned.

Bath & Hammondsport R. R.—Mr. John T. Parkhurst has been elected Vice-President, with office at Bath, N. Y.

Canadian Pacific.—Mr. Thos. Tait has been appointed Manager of the Eastern Division. Mr. Wm. Whyte has been appointed to a corresponding position on the Western Division.

Carabelle, Tallahassee & Georgia.—Mr. W. E. McCarthy has been appointed Master Mechanic at Lanark, Fla.

Chicago, Burlington & Quincy.—Mr. J. A. Carney has been appointed Master Mechanic at Beardstown, Ill. Mr. J. F. Deems has been appointed Master Mechanic at West Burlington, Ia. Mr. Max Wickhorst has been promoted to the position of Engineer of Tests at Aurora, Ill. These changes were occasioned by the death of Mr. C. W. Eckerson, who was recently appointed to succeed Mr. Joel West as Master Mechanic at West Burlington.

Chicago & Southeastern.—Mr. W. de Sanno has resigned as Master Mechanic.

Chicago & West Michigan.—Mr. C. M. Heald was elected President and General Manager, April 27.

Erie.—Mr. G. M. Cumming has been elected First Vice-President. Mr. H. De Calson Pratt, who was connected with this road from 1864 to 1873, died at Elmira, N. Y., May 4.

Eureka Springs.—Gen. Powell Clayton has resigned as President and General Manager and was elected Vice-President, and Mr. C. H. Smith, formerly Vice-President, has been elected President. Mr. George West has been appointed General Manager.

Everett & Monte Cristo.—Mr. A. B. Cherry has been appointed Master Mechanic at Everett, Wash., to succeed Mr. W. Irving.

Grand Trunk.—Mr. H. Roberts, Master Mechanic at Fort Gratiot, Mich., has resigned and his place taken by Mr. Robert Patterson. Mr. J. W. Harkom has been appointed Master Mechanic of its Eastern Division at Montreal, Mr. W. D. Robb is made Master Mechanic of the Middle Division at Toronto, and Mr. W. Ball is Master Mechanic of the Northern Division at Allandale.

Hutchinson & Southern.—Mr. A. L. Williams has been elected President.

Indiana & Illinois Southern.—Mr. C. P. Walker has been appointed Purchasing Agent.

International & Great Northern.—Mr. T. M. Campbell, General Manager, has resigned and will be succeeded by Mr. Leroy Tuice.

Lebanon Springs.—Mr. E. Sweet has been appointed Receiver vice Mr. W. V. Reynolds, deceased.

Missouri, Kansas & Texas.—Mr. A. A. Allen has been appointed Vice-President and General Manager, vice L. C. Purdy, resigned.

Norfolk & Western.—Mr. J. Cullinan, Master Mechanic at Portsmouth, O., has been appointed Foreman at the Portsmouth shops, the office of Master Mechanic having been abolished. Mr. Chas. S. Churchill, formerly Engineer of Maintenance of Way, has been appointed Chief Engineer. Mr. R. P. C. Sanderson has been appointed Master Mechanic of the line east of Roanoke with office at Roanoke. Mr. H. A. Gillis has been appointed to a corresponding position for the lines west of Roanoke, with office at the same city.

Northern Pacific.—Mr. E. W. Winter has resigned as President.

Oregon Railroad & Navigation—Mr. A. L. Mohler, formerly General Manager of the Minneapolis & St. Louis, has been appointed Vice-President and General Manager, with headquarters at Portland, Ore.

Oconee & Western.—Mr. A. J. Menter has been appointed Master Mechanic at Dublin, Ga., vice J. A. Long, resigned.

Philadelphia & Reading.—Mr. Edward M. Paxon has resigned as Receiver. Mr. J. D. Landis has been appointed Purchasing Agent, with headquarters at Philadelphia, to succeed Mr. Albert Foster, deceased.

San Antonio & Aransas Pass.—Mr. W. Green has been appointed Master Mechanic at Yoahum, Tex., and Mr. D. S. Hassett has been appointed Master Mechanic at San Antonio, Tex.

Seaboard Air Line.—Mr. John Warwick, General Purchasing Agent, has resigned and will be succeeded by Mr. O. D. Ball, Jr., with headquarters at Portsmouth, Va.

Second Avenue of New York.—Mr. Pierre Jay has been elected President to succeed Mr. J. D. Crimmins, resigned.

Silverton Railroad.—Mr. J. L. McNeil has been appointed Manager and Treasurer. Mr. Frank P. Thornton is Secretary and Auditor. The headquarters of both are at Denver, Col.

Texas & Pacific.—Mr. Gaston Meslier, Passenger and Ticket Agent, has resigned.

West Shore.—Mr. P. E. Garrison, formerly Master Mechanic at E. Buffalo, has been promoted to the position of Assistant Superintendent of Motive Power.

Wheeling & Lake Erie—Mr. J. B. Braden has been appointed Assistant Superintendent of Motive Power and Cars. Mr. O. P. Dunbar has been promoted from the position of Master Mechanic to that of Superintendent of Motive Power and Cars, with headquarters at Norwalk, O.

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

JULY, 1897.

CONTENTS.

MASTER CAR BUILDERS' ASSOCIATION--PROCEEDINGS OF THE THIRTY-FIRST ANNUAL CONVENTION.

The Thirty-First Annual Convention of the Master Car Builders' Association was called to order in Hotel Chamberlin, Old Point Comfort, Va., at 10 a. m. June 8, 1897, President S. A. Crone in the chair, and with an unusually large attendance.

The opening prayer was delivered by Rev. W. F. Shepard. and welcome to Old Point Comfort was given in a few hearty words by Col. Royal T. Frank, First United States Artillery, Commandant of Fortress Monroe. The President then introduced the Hon. Chas. D. O'Ferrall, Governor of Virginia. who addressed the convention in a happy manner, in which a high tribute was paid to the part taken by the mechanic in the progress of the world, not only with reference to transportation, but in his general influence over all industrial affairs. The mechanic was depended upon for progress in time of peace and for the defense of the country in time of war. A moving railroad train was the greatest wonder of the time and it was the result of a gradual advance from the crudest methods and appliances. The abridging of distance was, next to the printing press and the telegraph, the most important improvement of the age. A tribute was paid to the railroads for contributing to the high standing of this country in population and commerce and in this a large share was due to the car builders for their work in rendering travel safe. His closing words were of hearty welcome. The address was thoroughly enjoyed and frequently applauded.

The President called upon Mr. J. N. Barr to respond to Governor O'Ferrall. Mr. Barr's remarks were exceedingly appropriate, and were well received.

The minutes of the previous meeting were disposed of, after which the presidential address wes delivered by Mr. Crone. The effect of the new interchange rules was referred to as having had a most important influence upon the increased mileage of cars. It was recommended that the secretary of the association should be empowered to decide doubtful cases of arbitration on the interchange rules, and further that a charge of $10 should be made before the entertainment of any case of arbitration before the Arbitration Committee, the cost to be paid by the road losing the case. The appointment of a committee to decide upon a safe limit of life for iron and steel axles, giving the limit of sizes, was recommended. As to stenciling of cars the speaker thought it important to stencil the lengths as well as the diameter of all axles upon the trucks and to place the capacity of the cars upon their sides. Also it was considered desirable that when cars exceed 12 feet in height at the eaves or 14 feet high, at any point above the top of the rail, the figures should be noted on the car. He urged the importance of closely adhering to the association's standards, pointing out the fact that the members of the association have labored for many years to perfect standards which are very generally used in car construction, but the question which now confronts us was, what can be done to make them more closely adhered to. He recommended that a rule be adopted at the convention that Master Car Builders' standards and their necessary attachments may be applied, when practicable, without marring cars or impairing their strength, and that their use should be considered as proper repairs in interchange.

During the past year the association had lost by death the following members: D. L. Barnes, Osgood Bradley, R. E. Marshall, Peter Smith, L. Lightner, Joel West and F. H. Soule. Their deaths deprived the association of some who have been among the organizers and wisest of its counsellers, and others, who though younger in years of membership had already taken prominent part in the organization, as well as in the various departments of railway work in which they were respectively engaged. In cherishing their memories the association was but renewing allegiance to the principles of the association, to which they were loyally devoted. In closing, words of appreciation of the excellent work of the committees for the year were offered.

The Secretary, Mr. J. W. Cloud, then presented his annual report, which showed a net increase of 28 in the membership, which stands now 440, including representative and associate members. The Treasurer, Mr. G. W. Demarest, reported all bills paid and a balance of $6,096.23 on hand. Mr. Mackenzie suggested the omission of the dues for the coming year in view of the amount of the surplus, but no action was taken on account of the statement from the Secretary that the Executive Committee had decided to use from the surplus to defray the expenses of the members of committees in their work for the next year.

Under the head of new business Mr. S. Higgins suggested the transmission of the resolution of the association passed last year with regard to the adoption of the metric system to the American Railway Association. This was ordered done. An invitation to the association to attend the Tennessee Centennial Exposition was then read.

TOPICAL DISCUSSIONS.

After several other items of new business were disposed of the convention took up the discussion of the questions propounded by members, the first of which was: Should brakebeams on four-wheel passenger car trucks be hung outside or between the wheels?

Mr. A. E. Mitchell opened the discussion by stating the advantages of inside hung brakes. If hung inside they did not interfere with the removal of wheels; they permitted of compact construction; this did not require the use of release springs and a further advantage was offered of giving less recoil of the trucks in stopping trains. Mr. Mitchell had four cars so equipped with 96 per cent. brake leverage, and stated that the gain in the stopping of trains with the arrangement was about 20 per cent. over the outside arrangement and the sliding of wheels was reduced.

Mr. Barr thought that inside hung brakes would increase the sliding of wheels. The experience of members seemed to be generally favorable to inside hung brakes. Mr. Apps, of the Canadian Pacific, reported entire satisfaction with inside hung brakes when 90 per cent. of braking power was employed.

Mr. J. N. Barr then presented the subject: Advantages and disadvantages of the system of mounting car wheels as suggested

to the New York R.R. Club by Mr. George Tatnall at the February, 1897, meeting of that club.

He did not find any bad results of frog impingement on straight track, and concluded that guard rails did not prevent impingement of frog points on straight track. He recommended a throat opening of 2¼ inches on straight track. The guard rail was advantageous in preventing derailments but not impingements.

He asked: Why not use the present check gage for mounting wheels? The thickness of the flange would not need to be figured, and this gage might be used as a mounting gage without any trouble.

Mr. Mendenhall pointed out the importance of placing the standards and recommended practice of the association beyond the reach of criticism such as was offered by Mr. Tatnall's paper.

The next subject was: What is the best way to overcome injury to trucks and track due to salt-water drippings from refrigerator cars?

It was opened by Mr. S. Higgins, who stated that to the troubles previously experienced from this cause were added the corrosion of automatic signal bond wires. A sample pair of angle bars laid in 1890 showed that a single pair of splices, originally weighing 37 pounds, corroded to weigh only 29 pounds. Trucks had broken down on 15 refrigerator cars due to this cause on the Lehigh Valley Railroad. The proper solution of the problem seemed to be the use of ammonia in place of ice for refrigerating purposes.

Mr. Waitt urged the immediate use of tanks for catching the drips of these cars. By a vote on a motion by Mr. Lentz this subject was placed upon the list for report at the next convention.

The next topic, "Journal box lids. What reasons, if any, exist for or against the revising of our present standard in box lids?" was opened by Mr. R. H. Soule. The trouble was that of the wearing of the box by the lid requiring a new arrangement of the hinge. The spring also caused trouble by pressing the lid close to the top and leaving the fit a loose one at the bottom of the opening. He recommended the use of ground joints and an application of the spring to the center of the lid instead of at the top. Mr. Schroyer had been able to secure a dust-tight joint with a top-hinged lid by making it rabbeted along the sides. He used a light malleable iron lid.

Supervision of Standards.

The report of the Committee on Supervision of Standards was read by Mr. R. H. Soule, chairman.

Mr. Mendendall moved that the recommendations of the report be referred to the Executive Committee for the necessary action. Carried. No discussion.

Triple Valve Tests.

The chairman of the Committee on Triple Valve Tests reported that no triples had been submitted for tests during the year. No discussion.

Standard Wheel Gages.

Mr. Barr announced that the Committee on Standard Wheel and Gages had no recommendations to offer, and Mr. Potter stated that he was authorized to offer the use of a portion of track upon his road for train resistance tests to determine what is the best gage to use for wheels which are to run on a track gage of 4 feet 8½ inches.

The standing Committee on Brakeshoe Tests then announced that it had no report to offer, as there had not been a sufficient development on the subject to justify further tests.

Automatic Couplers.

The next subject was the report of the Committee on Automatic Couplers. The recommendation with regard to the change in the pocket strap was referred to letter ballot. Messrs. Rhodes, Barr and Lentz argued in favor of doing away with the lips on the ends of the straps.

SECOND DAY.

Automatic Couplers.

The session of Wednesday, the second day, opened with a continuation of the discussion of the report of the Committee on Automatic Couplers Vice-President C. A. Schroyer presiding. The action taken was to adopt the recommendations of the committee.

The report on Uncoupling Arrangements for M. C. B. Automatic Couplers was taken up. On motion by Mr. Bush it was ordered that the report be submitted for letter ballot for adoption as recommended practice.

Interchange Rules.

The revision of the interchange rules was then considered in connection with the report of the Arbitration Committee. The rules were read section by section. The early part of the discussion centered around the question of the responsibility for improper repairs. The first action was to adopt a recommendation to hold companies responsible only for improper repairs made by them, and this idea was inserted in the preface of the rules, this being the most important change which was made. The rule with regard to the owner's responsibility for worn flanges was modified as to dimensions. The principal participants in the debate upon the rules were Messrs. Rhodes, Chamberlain, Sanderson, Mendenhall, Bush, Waitt and Garstang. A number of changes were made in the rules and these were chiefly along the line of the report of the Arbitration Committee. Mr. Rhodes made a motion to the effect that to section 16 of rule 4 the following should be added: "Delivering companies shall not be held responsible for any wrong repairs to draft rigging and axles or wrong repairs to owner's defects not made by them."

Mr. Barr made some very pointed remarks about the use of repair cards, and was almost of the opinion that it would be wise to take summary measures with inspectors who did not make proper use of them. While discussing the revision of the rules the chairman read a communication from Mr. G. W. Booth, General Auditor of the B. & O. R. R., stating that he and Mr. L. F. Sullivan, Auditor of the C. & O. R. R., had been appointed by the Railway Accounting Officer's Association to confer with the M. C. B. Association with regard to the advisability of making changes in the rules governing methods for billing for repairs to foreign cars. The meeting was addressed by Mr. Booth, who expressed a strong desire that the heartiest co-operation should be had between the accounting officers and the car department officers. The absurdity of conducting expensive correspondence in connection with very trivial items was shown and the speaker dwelt upon the inconvenience of having bills referred to their authors for corrections after they had passed through the hands of the car department officers. Mr. Garstang moved the appointment of a committee to confer with Messrs. Booth and Sullivan upon this subject, and the following members were named for this committee: Messrs. Garstang, Haywood and Mitchell. The committee recommended that the last paragraph of rule 5, section 12, on page 5 of the report of the Arbitration Committee should be stricken out and the following substituted therefor:

"Bills shall not be rendered for amounts less than 25 cents in aggregate, but charges for items less than 25 cents may be held until they amount to that sum, provided said aggregate is rendered within 60 days; no bill shall be returned for correction on account of error for less than 25 cents, but request shall be made for credits and adjustment in subsequent month.

"All offices rendering bills should consolidate all charges against any one company into one monthly bill.

"Your committee further recommends that the Master Car Builders' Association appoint a standing committee to consider with the Committee of the Accounting Officers' Association questions relative to bills and accounting, such committee to report at each annual convention."

This report was adopted and Messrs. Hennessey, Sanderson and Bush were appointed as a committee to report recommendations in regard to the revision of prices for repairs to foreign cars.

Uncoupling Arrangements for M. C. B. Couplers.

The next subject introduced was the report of the committee entitled Uncoupling Arrangements for the M. C. B. Automatic Couplers. This will be published in abstract in a later issue of this journal. Upon a motion by Mr. Bush, the recommendations contained in the report were ordered to be submitted to letter ballot.

The following gentlemen were then proposed for associate membership: Messrs. Walter D. Crosman and Edward A Phillips.

NOMINATION OF OFFICERS.

The secretary announced that the nominating committee had submitted the following report for the officers for the year 1897-98:

President, S. A. Crone, N. Y. C. & H. R. R. R., New York.

First Vice-President, E. D. Bronner, Mich. Cent., Detroit, Mich.

Second Vice-President, C. A. Schroyer, C. & N. W. Ry., Chicago.

Third Vice-President, J. T. Chamberlain, B. & M. R. R., Boston.

Treasurer, G. W. Demarest, Northern Central R. R., Baltimore.

Three members of the Executive Committee to replace outgoing members were Messrs W. S. Morris, Samuel Higgins and C. M. Mendenhall.

The meeting then adjourned until Thursday morning.

THIRD DAY.

Interchange Rules.

The special committee appointed to revise the prices given in the interchange rules was the first to report. The suggestion that a standing committee on prices be appointed was offered to the association, and the prices were revised to bring them up to date. The report of the committee was briefly discussed, the question of territorial arrangements for prices being brought up by Mr. A. L. Humphrey, of the Colorado Midland Railway. Mr. Humphrey suggested that in order to secure fairness to Western lines 10 per cent. should be added to charges on repairs made west of the 105th meridian. Messrs. Small, Fowler and Childs supported Mr. Humphrey, while Messrs. Barr, W. H. Lewis, G. A. Marden and J. T. Chamberlain thought that the prices should not be increased for the West. Mr. Barr thought the question impossible for solution on the basis of equity. He considered the complications of adjustment a greater difficulty and more objectionable than the present injustices which applied in many sections other than in the West. The report of the special committee provided that this question should be investigated by the standing committee to be appointed. Mr. Humphrey put his suggestion in the form of a motion, which was voted down.

Mounting Wheels.

A report on the subject of mounting wheels was offered by Mr. Barr. The essence of this was the recommendation of the use of the standard check gage for mounting wheels. It was referred to letter ballot for adoption.

Interchange Rules.

Mr. Potter reported for the committee appointed to suggest a scheme for the presentation of cases to the arbitration committee concerning Rule 11. The cases were to be presented to the committee in abstract in the form of briefs signed by the parties in dispute. The report was adopted. The object was to relieve the committee of unnecessary labor, and to settle as many cases as possible without bringing them before the committee.

Upon motion by Mr. Waitt, the interchange rules as a whole were adopted as amended, and upon a subsequent motion the rulings of the Arbitration Committee were approved.

Loading Long Material.

Mr. Leeds presented the report of the committee on the subject: Loading Logs, Bark and Long Structural Material. Upon a motion by Mr. Waitt, the recommendations of the committee were referred to letter ballot for adoption as recommended practice for a year's experience.

Trains Parting.

Mr. A. M. Waitt read the report of the Committee on Trains Parting. In discussing it Mr. Simons urged that a new form of uncoupling attachments connected in a way to render them less liable to damage should be used, and he was supported by Mr. Waitt, who believed that attachments might be made directly to the couplers. Mr. Rhodes thought that the use of buffer blocks would greatly decrease the expense of repairs to draft rigging. The importance of these blocks should not be lost to sight. He found that solid buffers were entirely satisfactory in use on wooden cars, good results having been found from a recent application of them to 1,000 cars. Secretary Cloud called attention to the fact that the recommended practice of the association approved of their use. The report of the committee was accepted and the committee continued to enable them to put their own recommendations into practice, as the motion was expressed by Mr. Leeds.

Passenger Car Pedestal and Journal Box.

Mr. Geo. W. West presented the report of the Committee on Passenger Car Pedestal and Journal Box for Journal 4¼ by 8 inches. The report was referred to the Committee on Standards and was afterward adopted upon the recommendation of that committee.

Specifications for Cast-Iron Wheels.

The next subject was the report entitled: Specifications and Guarantee for Cast-Iron Wheels, read by Mr. J. N. Barr. The discussion consisted chiefly of questions and explanations with regard to the report. The thermal tests were indorsed by Mr. Barr as the best method of testing wheels. Mr. Atterbury moved that in the provisions of the report with regard to physical tests the thermal tests should be made in connection with the drop test. This speaker presented some interesting figures which tended to show the importance and value of the tests in the improvement of the quality of wheels. Mr. Atterbury's motion was carried.

TOPICAL DISCUSSIONS.

At noon the topical discussions were introduced, the first being: What is the exact meaning of the latter part of Rule 5, Section 8, in connection with replacement of wheels and axles? No discussion. The next subject was: "Would it be advantageous to adopt standard coil springs for freight car trucks?" This was introduced by Mr. Sanderson, who answered the question expressed in the topic in the affirmative. Mr. Waitt moved that the subject be referred to the Committee on Subjects for treatment next year. Mr. Sanderson's presentation of the matter was so complete and satisfactory that no discussion was offered.

Mr. W. C. Appleyard, of the N. Y., N. H & H. R. R., introduced the next subject: Copper sheathing for passenger cars; how is it applied and what are its advantages? The experiment recently carried out by the speaker was described, in which a passenger car was sheathed with sheet copper. The entire exterior of the car was covered with No. 28 copper, but No. 30 was thought to be more advantageous. The copper was oxydized after application. The appearance after a half year's use was as good as when new. Details of making the joints in the plating were described. The color was almost exactly that of the Pullman cars. Mr. Appleyard exhibited a sample showing the method of application. The cost of the copper sheathing was about $50 more than that of painting, and the saving expected is from the shop space and cost of repainting. The work could be done in the erecting shop, not requiring a special building for the purpose. Mr. Mitchell raised the question as to what effect the copper sheathing would have on the durability of the wooden sheathing. He thought that moisture might collect between the copper and the wood to the deterioration of the latter. Mr. Appleyard said that no trouble had been found with regard to expension and contraction, and that time would show the importance of this question. Great interest was shown in this subject.

Mr. F. W. Brazier introduced the topic: Is the retention of the dummy coupling desirable on freight equipment?" The speaker did not believe in either hanging the hose up in the customary way or in allowing it to hang down without protection

from dust. He thought the use of an automatic closing device for the hose coupling desirable. Mr. Rhodes reported entirely satisfactory experience with the practice of allowing the hose to hang down. He approved of using a closing device. Mr. Schroyer was not satisfied to let the hose hang down, owing to the accumulation of dust. He also approved automatic closing devices and thought the one formerly used by the Westinghouse Company the best that he had seen. Mr. S. Higgins found that he could get good results with the dummy couplings, the use of which he had not abandoned.

Thermal Tests for Wheels.

Mr. Potter gave some interesting comments upon the thermal testing of wheels, which will be published in full in a future issue of this journal. There was no discussiou ot his remarks.

Testing Laboratories.

Mr. Schroyer read a brief paper to introduce this subject. He strongly endorsed the plan of establishing such laboratories and made a point of the fact that steel was now more generally used than formerly in car construction. He recommended buying material on specifications, subject as far as possible to physical tests, and had found much inferior material in that which had been offered to his road. The establishment of testing bureaus among the roads was suggested. The apparatus was not very expensive and a man with a technical education was not absolutely required for the handling of such work. Mr. Sanderson also mentioned testing bureaus supported by several roads jointly. Such a plan was thought to have advantages over the present practice of separate testing departments on the various roads, Mr Rhodes gave strong support to laboratory testing and Mr. R. H. Johnson took the old-time view of the laboratory testing question, because tests, which should exactly resemble the shocks and stresses of service, could not be made upon machines.

Air-Brake and Signal Instructions.

This report was read by Mr. E. W. Grieves and it was referred to the committee again for further report next year. Some inconsistencies were found in it. After this the session adjourned.

FOURTH DAY.

Freight Car Buffers.

The session of Friday was opened at 9:30 a. m. with the reading of the report entitled, Improved Freight Car Buffers, by Mr. F. W. Brazier. The discussion was opened by Mr. Rhodes, who argued in favor of the use of solid buffers placed against the end sills, this arrangement being elastic enough and very nearly as effective as the spring buffers which were closed solid impact at very low speeds. Mr. Sanderson supported the previous speaker's opinion. Mr. Waitt thought that efforts should be made to reduce shocks to cars as far as possible. The present devices might not be strong enough, but the idea of spring buffers was good and the buffers should be applied opposite the sills whereby the stresses could be transmitted along the car frame. Mr. Waitt moved that the recommended practice concerning the details of buffer blocks should be submitted to letter ballot for adoption as a standard of the association. Carried.

Box-Car Doors.

The report entitled Box-Car Side and End Doors was the next subject. It was read by Mr. J. J. Hennessey. After a brief discussion Mr. R. H. Soule moved the adoption of the recommendations of the committee as recommended practice of the association.

Arch Bars and Column Bolts.

The next subject was the report entitled Arch Bars and Column Bolts of Diamond Trucks, which was read by Mr. J. E. Simons. There was very little discussion, and upon motion by Mr. Waitt, the recommendations of this committee were also referred to letter ballot for recommended practice.

Steel Car Frames.

The last of the reports of the technical committees was the "Joint report of five members appointed to present individual designs for steel underframing for freight cars," read by Secretary Cloud. The discussion was opened by Mr. Sanderson, who called special attention to the summary of the dimensions desired by the members for standard construction as expressed in the diagram presented in the report. Mr. Waitt moved the reference of the recommendation of the committee as to standard dimensions for cars to letter ballot as recommended practice for one year. Carried.

Mr. Waitt then made another motion to the effect that a new committee be appointed to consider the various designs submitted and recommend a design. Messrs. Barr. Sanderson and Joughins took part in the discussion, which consisted principally in explaining the designs submitted.

TOPICAL DISCUSSIONS.

Topical discussions were then taken up, the first being entitled "Is there any advantage in the use of M. C. B. Air-Brake Defect Cards?" which was presented by Mr. Thos. Fildes. These cards were important because they gave information to the trainmen as to the condition of the air-brakes upon cars and without them much trouble and delay was occasioned by the absence of definite information as to what was wrong when brakes were cut out. The cards were considered as very valuable and several members strongly advocated their employment.

"Is it a safe and advisable practice to splice air-brake hose, and should such hose be condemned in interchange?" was next introduced by Mr. Rhodes, who stated that for a cost of 7½ cents a hose could be spliced as against 75 cents for a new hose. He showed that this amounted to a saving of $1,800 per year for one of the shops on the C., B. & Q. R. R., an item worthy of consideration. If good material and workmanship were used there was no objection to the use of spliced hose and it was economical and permitted the saving of hose which was but slightly damaged. The association by vote expressed its opinion to the effect that the proper splicing of air-brake hose was a safe practice.

In the discussion of the topic with regard to the advantages of adopting an M. C. B. coupler defect card, Mr. Rhodes advocated the use of such cards.

The subject of specifications for air hose was introduced by Mr. Waitt, who gave an interesting exhibition of samples of air hose, showing the great differences in quality of this material, which is in ordinary use. He urged the great importance of improving the quality of hose. Mr. Barr agreed with Mr. Waitt in believing that it would be safe to use two-ply hose. He did not believe in specifying high pressure tests or in guarantees. Mr. H. M. Carson recommended elasticity tests of hose, that hose being best the rubber of which would show no permanent set after stretching.

After brief discussions on the remaining questions which had been propounded, and action referring the question of a uniform system for locating defects on repair cards to the committee on subjects, the report of the committee on subjects was presented and referred to the executive committee. The usual resolutions in recognition of the courtesies and privileges enjoyed by the members of the association were then presented and adopted.

Instead of nominating places for holding the next convention, it was decided to take this up in connection with the letter ballots to be sent out by the Secretary.

The next business was the election of officers, and by vote the Secretary was instructed to cast ballots for the gentlemen mentioned in the report of the nominating committee already given.

The convention adjourned at 12:10 p. m.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION—PROCEEDINGS OF THE THIRTIETH ANNUAL CONVENTION.

The thirtieth annual convention of the American Railway Master Mechanics' Association was opened at Old Point Comfort, Va., June 15, 1897, President R. H. Soule in the chair. After the opening prayer by Rev. W. F. Sheppard, the address of welcome was given by Col. H. C. Hasbrouck, who in the course of his remarks explained the purpose of the artillery school at Fortress Monroe, stating that one-fourth of the whole artillery force of the United States army was stationed at that post. He gave a cordial welcome to the association.

The presidential address was delivered by Mr. R. H. Soule, who spoke first of the appropriateness of holding the convention of a national organization upon national property. The membership of the association at the first meeting was 41, and it had grown to be the largest of the railroad technical organizations. The subjects of the early conventions were briefly reviewed as indicating the rapid advances made in the designs of locomotives. Most of the work in the improvement in this line had come within the 30 years of the life of the organization. Since the last meeting much progress had been made. Higher pressures were now the rule even with simple engines, 180 pounds being now very common. Large driving wheels, the use of piston valves, the reduction of weights of reciprocating parts, the use of larger cylinders, constituted marked steps in advance. Reduced lead and the use of inside clearance were also mentioned along with the increasing use of cast steel in locomotive construction. Boiler-feeding devices had been greatly improved. Heavier locomotives were approved even if the track required strengthening. The general adoption of the tonnage system of rating trains had been a feature of the year. The compound locomotive was still in the balance, but it had doubtless gained friends during the year, and progress had been made in the locomotive from a commercial standpoint. The adoption of the Master Mechanics' decimal gage by the American Steel Manufacturing Association and the American Society of Mechanical Engineers was a pleasing endorsement of the work of the association. Mr. Soule saw a good result from the "hard times" in that the work of the members were improved through the necessity for frequently asking the question: "Will it pay?" In this connection the railway clubs had contributed valuable assistance, with good effect, in the discussion of questions of economical operation. The important suggestion was made that the two annual conventions of the Master Mechanics and the Master Car Builders' Associations might be held in one and the same week, saving valuable time of the members.

Among the suggestions for work for the next year was that a committee should be appointed to investigate and report upon the subject of the application of electricity to tractive purposes.

The minutes of the previous meeting were adopted as printed and the report of the Secretary was presented. At the last meeting the membership was as follows: Active, 615; honorary, 24; associate, 18; total, 657. This year the figures stood: Active, 577; honorary, 26; associate, 17; total, 620.

The amount of cash on hand, as given in the report of the Treasurer, was $1,659.01, all bills having been paid. This report, as well as that of the Secretary, was referred to an Auditing Committee composed of Messrs. Henderson, Lawes and Sinclair. The report showed the accounts to be correct.

Under the head of unfinished business the proposed amendment to the constitution which provides for a Third Vice-President was taken up and carried. The regulations with regard to the association scholarship as provided by the constitution were amended to the effect that in case the scholarships were not taken up by the sons of master mechanics at the time of the June examinations they should be open to the sons of railroad employees or of deceased employees. It was provided that employees or sons of employees in the mechanical departments should have the preference over others.

Mr. E. C. Bates was elected to associate membership, and Messrs. C. H. Prescott and W. H. Stearns were elected honorary members of the association.

A communication was read from Mr. Henry Schlacks, Superintendent of Motive Power of the Denver & Rio Grande Railroad, taking exceptions to the remarks which were made at the convention of last year by Mr, Angus Sinclair with regard to burned crown sheets on that road. This called forth an explanation by Mr. Sinclair of the remarks referred to, which were not intended as a reflection upon the road mentioned or its officers, and the remarks were stated to have been made upon what was believed to be good authority. This was accepted by the convention as an acknowledgement of error.

In accordance with the suggestion of the President, Mr. W. H. Lewis then presented a resolution to the effect that the executive committee should be authorized to arrange the days and the hours for the next convention with a view of consolidating the meetings of the Master Car Builders' and the Master Mechanics' Association into a single week, the opening exercises to be consolidated also. A conference committee of 11 members including the members of the Executive Committee was provided for, to take up the subject with the Master Car Builders' Association by a joint meeting with 11 members of that association. This was carried.

Mr. Wm. Forsyth moved that the executive committee should be instructed to invite a railroad president, manager or chief engineer to present an address to the association at the next convention, this being in accordance with a suggestion offered by Mr. M. N. Forney in an article published in the June issue of the American Engineer, Car Builder and Railroad Journal, the details of time and place for the address to be left with the Executive Committee.

TOPICAL DISCUSSIONS.

Piston Rods.—Mr. G. R. Henderson introduced the subject which was important on account of the breakage of piston rods and their weight also constituted a source of trouble. The only way to lighten them was to make them hollow and a number of experiments had been tried with tubular rods, which included tensile and compressive tests. He exhibited a drawing of the articulated crosshead, which was illustrated in the American Engineer, Car Builder and Railroad Journal of June, 1897. This was designed for the purpose of reducing the breakage of piston rods. Mr. Vauclain stated that the saving of weight of a rod when hollow was about 50 per cent., the cost not being greater than the solid rods. Mr. Platt described practice in the use of hollow piston rods by Messrs. Thorneycroft in torpedo boat construction. The engines were high speed and ranged up to 3,000 horse-power. The practice was very satisfactory. Cold-drawn tubing was recommended. Mr. J. D. Barnett, of the Grand Trunk, had used tire steel for piston rods for three years with satisfactory results and was not afraid to use high carbon steel for this purpose.

Mr. R. Quayle gave a good report upon his experience with nickel steel. The rods were of small diameter, with enlarged ends, which distributed the flexure over the entire length of the rod, and no failures were had in two or three years experience. Mr. A. W. Gibbs strongly advocated enlarging the ends of rods to increase their strength, He recommended stiff high carbon steel as being better to withstand shocks. Nickel steel had the advantage of cracking and giving warning before breaking. This material did not weld, and it was likely to contain seams, which, however, did not interfere with its satisfactory use for piston rods. He considered it the best material for piston rods.

Compound or Simple Locomotives.—Mr. W. S. Morris gave the record of a Richmond compound, covering four years of service, as compared with 10 simple engines running in the same work. Repairs cost about one per cent. more for the compound than for the simple engines. The fuel consumed with 18 per cent. increased mileage was about six per cent. less for the compound. It was more economical in the use of oil and ran 19.2 per cent. more miles per ton of coal. Six compounds compared with the same number of simple engines for last year were more economical than the simple engines. Mr. Wm. Garstang supported Mr. Morris in regard to the saving in fuel by use of the compound, his experience being had with the Richmond Locomotive Works' type of compound, and stated that he had found the advantage to be about 17 per cent. Mr. George Gibbs gave comparisons between 11 simple engines and 11 Vauclain compounds, which showed the compounds to average 20.3 per cent. in saving over the simple engines, all of the compounds being cheaper than the best simple engines in the use of fuel. Mr. R. Atkinson's experience had been very favorable to compounds. He had been able to save about $2,000 per year with each compound over the simple engines with coal costing about $2.70 per ton. Mr. Quayle had found great differences between two cylinder compounds with various ratios between the areas of the cylinders. He had found a ratio of 2½ to 1 to be the best as to economy. Mr. Herr added to the testimony favoring the compound. All of the speak-

ers reported in favor of that type, showing that in their opinions the compound had come to stay.

COMMITTEE REPORTS.

Exhaust Nozzle and Steam Passages.—This report was presented last year, and the subject was continued to obtain results from a year's experience with the front end arrangements as recommended by the committee. Mr. Wm. McIntosh and Mr. T. J. Hennessy reported favorably upon the practice recommended by the committee, and the session adjourned before finishing the discussion.

SECOND DAY.

The first business of this session was the admission of Mr. E. F. Moore, Mechanical Engineer of the Railroad Commission of the State of Michigan, to associate membership. The Auditing Committee then reported the accounts of the Treasurer and Secretary to be correct. The reports were then resumed.

Exhaust Nozzles.

Mr. E. M. Herr, of the Northern Pacific, reported upon his experience with the recommendations of the committee on exhaust nozzles and steam passages. He gave evidence which was favorable to the arrangements recommended by the committee. Mr. R. Atkinson, Canadian Pacific, described his experience, which had shown him that he could save coal and avoid throwing sparks from the stack, by using the recommended arrangements, though he had not been able to enlarge the exhaust nozzles to any great extent. The steaming of the engines was improved and the fires were thinner, being only about one-half as thick as formerly and light firing was required. Mr. Cockfield, C. & N. W. Railway, was the next speaker. He had been able to decrease the cost of hauling trains about 16 per cent., stated in terms of pounds of coal per car-mile, by the use of the new front end arrangements.

The report by Mr. P. H. Peck, C. & W. I. Railroad, was also favorable to the new plan, and Mr. J. E. Sague, of the Schenectady Locomotive Works, spoke from the standpoint of the locomotive builders. The recommendations had been carried out in the building of locomotives, and from reports received he was led to believe that the recommendations constituted a marked improvement. Mr. Wm. Forsyth pointed out the importance of making the choke of the nozzle large enough for the largest tip which was to be used. The relation between the choke and the exit of the pipe was the really important feature of the recommendation and the choke should not be smaller than the exit. In the remarks of to-day the favorable reports of the previous session were generally supported, yet several members failed to find the arrangements economical. Professor Goss remarked that it was not necessary to the justification of the report that improved economy should be found in the use of the arrangements. To design draft appliances with certainty of obtaining the desired results in operation was one of the purposes of the investigation.

Counterbalancing Locomotives.

This subject was introduced by Mr. Herr. The difficulty in getting sufficient counterbalance in the small driving wheels of some consolidation engines was referred to by Mr. Henderson He believed that there was no reason why the weights should be distributed equally among the wheels, and was supported by Mr. Leeds, who would put the excess in the main and the intermediate wheels and balance only the revolving weights in the forward and rear wheels of consolidation engines. Mr. Wm. Forsyth took up the relations between the counterbalance and the section of the rails, quoting interesting experiments conducted on the Boston & Albany, the C. B. & Q. and the Pennsylvania Railroads by Mr. Howard, of the Watertown arsenal, and offered the suggestion that the civil engineering side of the question should be considered with special reference to the maximum allowable stresses in the rails.

Truck Swing Hangers.

This report was read by Mr. Wm. Garstang, and owing to the completeness of the report and to delays in the work of the session there was no discussion.

Locomotive Grates.

Prof. H. Wade Hibbard read this report by abstract.

Mr. H. A. Gillis reported satisfactory experience with the alternating use of anthracite and bituminous coal on the same engine one being used for one direction and the other for the opposite direction. It was not done from choice, but could be done if necessary without trouble.

The Apprentice Boy.

The subject was brought before the meeting by Mr. W. F. Bradley, who introduced it by a few remarks, in which comment was offered upon the tendency for operating officers to give more attention than do mechanical officers to the questions affecting the education and preparation of employees for their duties.

Mr. Robinson read the recommendation of the committee to the effect that a standing committee be appointed with very wide powers for the purpose of negotiating with institutions of learning with a view of experimenting in the line of university extension. In the discussion the trade portion of an apprentices' education was given a more important place than the academic work. Mr. Vauclain referred to the difficulties of interference between the care of old employees and the admission of apprentices. He approved of taking apprentices, educating them and then discharging them unless they were needed in the working forces. His plan would improve the boys in that the protection of the shops would be removed at the completion of the instruction. It would also make rooms for others. He believed that shops should be opened all over the country as manual training schools on such a basis as he described. Mr. Gillis supported the plan of turning apprentices away for experience after finishing their courses. Mr. Morris then moved that the recommendation of the committee be adopted to the effect that a standing committee be appointed to report upon the subject of the "Apprentice Boy" without a statement of the limitation of the powers of the committee. Carried.

TOPICAL DISCUSSIONS.

Cylinder Clearance.—The economy of large cylinder clearance was in question. Mr. Angus Sinclair took the position that large clearances led to a great waste of steam. Foreign practice was an improvement upon ours, owing to shorter steam passages, and this was believed to be the only advantage possessed by European over American locomotives in leading to more economical operation. Mr. Herr believed that excessive clearance was not conducive to economy; but the better performance of European locomotives was thought to be due to better qualities of coal and to the fact that foreign trains were lighter than ours.

Piston and Slide Valves.—Mr. Wm. Forsyth referred to the fact that piston valves were more generally used in compound than in simple locomotive practice, though he could see no satisfactory reason for this.

Piston valves were difficult to set, and it was important that the ports should be square and that the steam should be allowed free admission into the ports. He gave good accounts of the wearing of the valves, and stated that the rings should be as deep as could be sprung on. These valves gave little friction, and were believed to have advantages over slide valves, especially for high pressure. The balancing made it possible to handle the reverse levers easily, which was very important. Mr. Quereau believed the Allen port to be a valuable adjunct to a valve, and one objection to the piston valve was that this port cannot be used with this type.

Water on Locomotive Bearings.—Mr. A. E. Mitchell had found it possible to use water on locomotive bearings with success. Mr. Herr objected to the statement that water was a lubricant, and believed that water should be used only in cases of emergency. Mr. West had good results by using water in circulation over the driving axles of wide firebox locomotives, the central part of the axles being cooled thereby.

Manual vs. Automatic Control of Compound Feature of Compound Locomotives.—This subject was introduced by President Soule, whose experience had been with the Vauclain type, which had manual control, and his preference was for that form of control. Mr. Morris approved of an automatic control which could be operated manually, if necessary. Mr. Herr stated that the only compound locomotives which had given him any trouble

were those which could not be controlled manually when desired. This view was supported by Messrs. Mitchell, Gibbs and Quereau. Mr. Henderson argued that inasmuch as manual control was desirable, the superfluous complication of automatic controlling devices should be avoided.

Irregular Wear of Cylinders.—Mr. W. A. Brown referred to the fact that the top walls of cylinders frequently wore more than the lower ones. This was believed to be due to inequalities in cylinder material. Mr. Herr, however, thought that such wear was due to poor fitting of the bull ring, while Mr. G. W. West attributed it to the influence of the crosshead and piston rod. The discussion was very brief.

Lead for Locomotives.—This was opened by a communication by Mr. E. L. Coster, who enumerated the well-known advantages of reduced lead. He suggested the appointment of a committee to report upon the subject to the association with recommendations for practice with different valves.

Broken Staybolts.—Mr. T. A. Lawes read a brief written discussion of this subject, which contained a description of tests on the breaking of bolts by drilling into the bolts. The hammer test was shown to be a failure as to detecting partially broken staybolts. Either hollow stays should be used or the staybolts should be drilled. The extra cost in his estimation was not important.

Mr. MacKenzie preferred giving greater water space to the drilling of staybolts. Mr. McIntosh believed in drilling the bolts and practising close inspection. Mr. Vauclain approved of the drilling of staybolts when new and also would reduce the diameter of staybolts between the sheets.

After the discussion of this subject the committee reports were again taken up.

Best Metal for Cylinders.

The conclusions of this report were read by the Secretary, and Mr. G. R. Henderson opened the discussion with remarks upon the practice of the Norfolk & Western Railroad in the use of steel mixtures in cylinder castings. The strength and wearing qualities of the mixtures were favorable. Mr. McIntosh suggested the use of cast-steel cylinders with cast-iron bushings, the advantages being great strength combined with good wearing qualities.

Mr. Leeds questioned whether steel and iron could be satisfactorily mixed before casting. Mr. S. M. Vauclain, of the Baldwin Locomotive Works, read a brief paper upon the subject of the cast-iron cylinder mixtures used at those works.

Grate and Heating Surfaces and Cylinder Volumes.

This was read by Mr. G. R. Henderson. It was the most exhaustive and ingenious report of the convention and excited much favorable comment. It involved great labor and research on the part of the committee and was unquestionably appreciated. Mr. Herr opened the discussion by calling attention to the report at the first presentation of a method of getting at the subject of the relations between grates, heating surface and cylinder dimensions. Professor Goss complimented the report for its ingenious analysis. The discussion was very brief, probably on account of the fact that a large amount of study was required in order to prepare for handling it intelligently.

Boiler Jackets.

The discussion on this subject was also very brief, and special attention was called to the fact that the Master Mechanics' standard gages were not used by those who replied to the questions asked by the committee. This sort of thing justified the criticisms frequently offered to the association to the effect that standards were adopted only to be disregarded by the members. Upon vote by the association the sizes of the sheets mentioned in the report were ordered translated into the terms of the standard gage, and also references to this part of the discussion were ordered expunged from the records of the meeting. The session then adjourned.

THIRD DAY.

Piece-Work in Locomotive Shops.

Mr. Pulaski Leeds, chairman of the committee, presented this subject with a brief explanation of the conclusions of the committee. Mr. McConnell opened the discussion with a statement to the effect that he had never favored piece-work systems in railroad shops. It was, however, very successful in contract shops wherein the work consisted largely of duplication. He did not consider the conditions in railroad shops as suitable for such systems. Mr. Wm. Swanston's remarks had to do chiefly with wages, and he believed it to be important that men should be assured that their wages should not be reduced under piece work system. He deprecated the practice of comparing prices between various shops where conditions must necessarily be different. Mr. Rufus Hill heartily endorsed the piece-work system. Its influence upon the men was good, as it encourages them to their best efforts, and altogether he had found it successful. He urged good management of the system, and agreed with Mr. Swanston with regard to comparing prices. Mr. L. R. Brown (P. R. R.) placed great stress upon showing the men that they have the opportunity to increase their wages by piece-work rates, and the earnings under that system were increased upon the road with which he was connected. Fairness to the men and a complete understanding between men and officers was important. Taylor's system was endorsed and its underlying principles were considered in the system used at the Juniata shops. It was thought necessary to apply the system to helpers as well as to machinists and these share in the results of their extra efforts. The apprentices did not share in such increase because of the extra care required from the foreman in their education. Mr. H. A. Gillis spoke of the necessity of most careful attention to the establishment of prices. In his system the apprentices did not share in the increased production, but the machinist obtained the benefit of the apprentice's efforts, which tended to cause the machinist to develop and instruct the apprentice to the best of his ability. This improved the instruction and was fair to the boys. He did not approve of applying piece-work in boiler shops, where no chances should be taken in regard to the quality of work. It was also difficult to apply it to erecting work. Mr. Herr brought up the question as to whether piece-work was necessarily poor work. Mr. Brown replied to the effect that in piece-work it was necessary to watch the work rather than the man. For this reason flue and riveting work were placed upon the day-work schedule. There were portions of locomotive work which could not be satisfactorily handled under the present piece-work system. This system seemed to imply to the men the rule that as much work as possible should be done in the shortest possible time. This was not to be considered as dishonesty, but was due to the natural failings of men. There were, however, many items which brought better results under piece than under day-work. Mr. Rufus Hill had been successful with piece-work in the boiler shop by the use of penalties. In the discussion considerable weight was placed on the inferiority of work under piece-work systems, several doubters of the value of the system having made their objections known. In spite of this, however, it was clearly shown that careful administration of the system made it desirable in a great many processes, but careful inspection was very necessary. Mr. Deems expressed his opinion of piece-work as being a means of taking up the lost motion between jobs.

Motors, Steam, Air and Electric.

Mr. J. H. McConnell presented a few of the chief features of the report and gave some information, not contained in the report, with regard to the cost and operation of electrical apparatus. In the discussion cautions were given against using air-hoists and similar appliances where the work could be better done by hand. Reheating was mentioned as an adjunct worthy of attention and one speaker strongly advocated a combination of pneumatic and hydraulic systems for press work owing to the trouble from the elasticity of the air. Mr. Geo. Gibbs commented upon the comparison between air and electric tools. Electricity had not been successfully applied to drilling, but this was probably due to lack of attention to the subject by men who were familiar with the requirements for such work. This was a field worthy of investigation. He mildly criticised the report because it did not contain more comparisons between the different motors, but was rather a report upon labor-saving appliances.

Air Brake and Signal Instructions.

This was a joint report between the two associations and it was explained that the subject was continued by the Master Car Builders' Association for perfecting the report for presentation next year. The Master Mechanics' Committee was likewise continued.

Mr. P. H. Brangs then read a brief paper upon the subject of electric locomotives as applied to steam railroads. It contained suggestions with reference to the possibility of the use of electricity for the purpose of meeting the competition of electric street car lines and advocated the equipment of several tracks of the suburban lines of trunk railroads with electricity. By vote it was ordered that the paper be published in the proceedings and that the discussion thereon be held at the next convention.

The closing subject was the report of the committee on subjects for the 1898 convention. The report of the committee on resolutions was then adopted.

Messrs. C. H. Quereau, W. H. Thomas and Philip Wallace were appointed as a committee on the assignment of members upon committees for the 1898 convention.

The election of officers resulted as follows: President, Pulaski Leeds; First Vice-President, Robert Quayle; Second Vice-President, J. H. McConnell; Third Vice-President, W. S. Morris; Treasurer, J. N. Barr.

Topical Discussion.

The last subject, "Research Laboratory Under Control of American Railway Master Mechanics' Association," was introduced by Prof. Goss. It was briefly discussed with regard to a possible plan for adoption. It was not a part of the scheme that the larger roads should abandon their laboratories. Each road would pay for what work it required to be done, and the work would be confined chiefly to routine matters.

The expression of opinion with regard to the best place for holding the next convention included Niagara Falls, Denver and Saratoga, but no vote was taken.

The convention adjourned at12:20 p. m.

A Locomotive with Auxiliary Gear.

The Bavarian State Railway has recently received a lot of 12 new compound locomotives from Messrs. Krauss. & Company, of Munich and Linz, and one of them is of the peculiar design shown in the accompanying illustration, which is reproduced from *Engineering*. The owners of this locomotive do not appear to have absolute confidence in the design, since they specified that the arrangement should be so made as to render conversion into the ordinary type easy in case the auxiliary gear should to prove to be satisfactory. The object sought was to combine the chief advantages of uncoupled wheels with the greater tractive force which four coupled engines afford in starting and in mounting grades. It was desired to secure a more perfect adaptability of the engine to the various requirements concerning speed and power during ordinary working. The advantage possessed by very large cylinders in giving great power at slow speeds was sought by a means which was expected to avoid the disadvantages of large cylinders at high speeds. The design provides adjustability of cylinder power to suit the needs by using a pair of cylinders working a single pair of large driving wheels, and adding an auxiliary engine of another pair of cylinders, below the first, working a pair of small wheels immediately in the rear of the rear truck wheels. This engine was put into service in December, 1895, and has been at work ever since with the exception of the time when it was at the Nurnberg exposition. The following is taken from the description of the engine given by our contemporary referred to:

The main pair of cylinders drive the 73.2-inch wheels. The diameter of the right-hand high-pressure cylinder is 15.16 inches and that of the left hand, or low pressure, is 24.01 inches.

The stroke in both cases is 24 inches. The cylinders are inclined 6 in 100, because the auxiliary cylinders had to be placed underneath, not to interfere with the engine profile. The valve chests, which are fitted with American balance slide valves, also lie inclined, in both the longitudinal and transverse directions. The valve gear is of the Heusinger-Walschaert type. The cut-offs are the same on both sides, while the cylinder ratio is 1: 2.51.

The receiver pipe passes through the smokebox, and bears above a safety valve loaded to 5.5 atmospheres, and in front a Ricour air suction valve, as shown. The starting gear consists of a Lindner cock, which is connected with the reversing rod, and at full gear allows the steam to pass from the boiler to the receiver, and of a Krauss interruption slide, which, fixed outside the high-pressure cylinder and worked from the right-hand link, prevents the passing of steam at those positions of the crank when the pressure in the receiver would only impede the starting.

This auxiliary engine is intended to insure a reliable and powerful start. It is entirely independent of the main engine and is fitted with two equal-sized cylinders. It is not in use except when a heavy pull is needed, that is, in starting and on steep hills. Under ordinary conditions the wheels of the auxiliary engine are kept off the rails and remain stationary. The wheels are 39 3 inches in diameter, the same size as the trailing wheels. The auxiliary driving axle has its bearings in pedestals which are formed by plates riveted to both sides of the main frame. This axle has not any ordinary bearing springs, but is connected with the springs of the main driving axle in such a way that these springs tend to lift the auxiliary axle from the rails and press its bearings against the upper stops. Normally, therefore, the auxiliary driving wheels remain 1.2 inches above the rails. When the auxiliary engine is to perform its duty, the auxiliary driving axle is depressed by the action of the piston of a vertical steam cylinder of 16.2 inches in diameter, fixed above its centre. The piston with its ball-socket joint and bronze foot-step bears against a cast steel support, fixed between two plates which connect the bearings. Steam is admitted through a three-way cock, which is seen on the right-hand side of the dome in the perspective view.

The levers between the auxiliary axle bearings and the bearing springs of the main driving axle serve the further object of equilibrating the load when the auxiliary axle is lowered, in such a way that the load is distributed over the running wheels. When the auxiliary wheels are pressed down the whole engine is raised about 1 inch on the springs; at the same time, however, the front links of these springs are depressed by about 2 inches, so that the deflection of the springs, and consequently the load upon them, remain unchanged. When the auxiliary motor is out of use the weight available for adhesion consists of the dead weight of the main driving wheels and their attachments, amounting to 3.73 tons, plus the load on the driving springs, amounting to 11.12 tons, making a total of 14,85 tons. When the auxiliary axle is pressed down, however, the following additional adhesion weight becomes available:

	Tons.
Deadweight of auxiliary axle and its attachments	2.130
Pressure on piston of loading cylinder	17.330
	19.460
Less upward pressure exerted at the point B by the levers connected to the driving springs	4 635
Additional adhesion weight	14.825

It will thus be seen that the adhesion weight amounts to 29.67 tons when the auxiliary axle is being used, and to 14.85 tons in the other case. The total pull of the engine is 14,462 pounds.

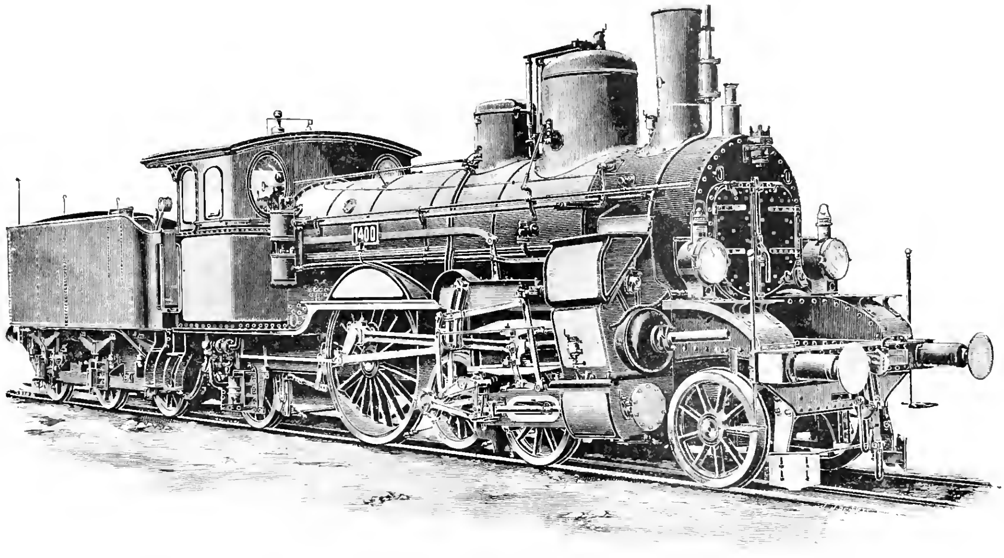
The cylinders of the auxiliary engine, which have a diameter of 11.4 inches and stroke of 18.1 inches are bolted to the lower side of the large cylinders; their valve chests lie horizontally and point outward.

The throwing in of the auxiliary engine has taken place when the locomotive was running at speeds up to 46.6 miles. The operation was so smooth that persons standing on the engine and and not watching the driver did *not notice the change over*. It has, moreover, been found that the switching in will rarely be required while the locomotive is in motion. It soon became apparent that the help of the small engine was needed over short distances only.

The complicated construction and the large number of axles have been commented upon adversely. With regard to the

former point, it may be said that the four-cylinder engines of Mallet and De Glehn, whose right of existence nobody questions now, are certainly not any simpler. A four-coupled engine of the latter type has, on the contrary, two more coupling-rods and four more bearings, and the secondary mechanism is essentially more bulky than the auxiliary engine. It is further to be considered that De Glehn's secondary mechanism is always running, which means additional friction, oil and repair. With the auxiliary engine under notice, which is idle for 95 per cent. of the run, those additional expenses come in to the amount of 5 per cent. only. There is a further advantage as compared with compound locomotives fitted with change-over gear, in being able to work with fresh steam in both engines. Such locomotives have to resort to strong throttling, and hence to waste steam, while the main and the auxiliary engines of Messrs. Krauss & Company work with full boiler pressure.

As concerns the second point, the locomotive has exactly as many driving and carrying axles as the "American Atlantic" type, which is more and more coming to the front. Together with its three-axled tender, it has not any more axles than the normal "American" class, with its four-axled tender.



Locomotive with Auxiliary Driving Wheels, Bavarian State Railway.

Electricity Under Steam Railway Conditions.

BY GEORGE S. STRONG.

(*First Paper.*)

Much has been written within the last few months regarding electricity taking the place of the locomotive for steam railway work, and a great deal has been said by the daily press, as to the possibility of electricity driving the locomotive out of use. Much of this talk is absolutely without backing in the way of facts, and very labored efforts have been made by electrical railway engineers to prove that, by the adoption of electricity, steam railways are in some way to reap a benefit, although they arrive at the conclusion that it is going to be very much more expensive in first cost and cost of operation; but somehow, they figure out that, by reason of the use of electricity, the traffic is to be so much increased as to warrant the increased expenditure. There is no doubt that by giving similar service to that which electrical railways give on suburban lines, a large amount of business can be retained and business can be increased by existing lines. The electrical roads have demonstrated that, by frequent train service with a low fare, more people will travel than if they have to wait and be guided by a timetable with higher rates. This lesson is one that should not be lost by the steam railway companies, and they are looking with great interest to some method that will enable them to give similar service without having to resort to the enormous expense incidental to the use of electrical equipment.

One of the most interesting of the articles that have appeared lately on this subject, is published in the *Engineering Magazine*, May and June, 1897, by Charles H. Davis, who is an authority on electrical railway matters. Mr. Davis starts out as an advocate of the introduction of electricity into suburban and inter-urban traffic, and his first article might lead one to believe that there is something to be gained by steam railways in making such a change, as he gives for comparison the amount of business done between steam and electrical railways in New England, showing the very large increase in numbers of passengers per mile and increased earnings per mile of electrical over steam railways, but his comparison is hardly fair, as the electrical railways considered are in centers of immense populations. If steam railways were operated under similar conditions the comparison would be fair, but the steam railways are taken for the entire New England States, reaching across large sections of country, where the population is not so dense as it is in the sections where the electric railways are operating.

Mr. Davis starts out as an advocate of the use of electricity for suburban and inter-urban traffic only, and carefully states that it is only to be considered for these purposes and that he does not advocate it for the use of long-distance traffic or for freight, and his main belief is that, by the special kind of service rendered—that is, very frequent trains that take one from his door to his office, or from the suburbs to the center of the city so as to avoid the use of other means of transit—that the gain is to be made. This is undoubtedly true, and we will endeavor to show that this service can be rendered without the use of electricity.

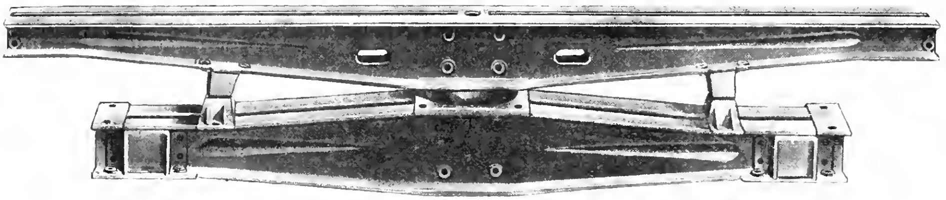
The main advantage of electricity and the service that is being rendered by it as against steam, is, that one is taken up at his door and landed within a reasonable distance of his office, or in the heart of the city, without having to pay two or three fares to reach that point. Another advantage of the electrical system, or system that can be worked out to operate in competition with it as against the present methods of steam railways, is that the units are much smaller and lighter than are now operated, and they should be operated at a much lower cost per mile.

One of the difficulties of modern railway practice has been a tendency toward very much heavier rolling stock, with heavier locomotives, and the point has been reached when the amount of dead weight in proportion to the paying load, is very great. The problem then, for this kind of work, is the development of a motor and car combined that will reduce the amount of dead weight to paying load to a point where the cost of operation will be reduced, and also where, by reason of the reduced amount of dead weight, more frequent stops can be made without loss of time.

The average American train now consists of five cars, each weighing 30 tons, and the locomotive and tender weighing 90 tons, making a total of 240 tons, the seating capacity for such a train being sufficient for about 300 people. Allowing 125 pounds for each passenger would give the weight of 18¾ tons as the paying load, or about 13 tons of dead weight to each ton of paying load. I believe the average American railway practice is 11 tons of train to every ton of passengers.

A motor car weighing 30 tons can be built on modern principles, taking advantage of modern materials, that will have a seating capacity of 100 people, and having motive power on it, entirely independent and self-contained, capable of developing 400 horse-power and capable of hauling, besides its own weight, four other cars of the same capacity, each weighing 20 tons and each capable of seating 100 people. This would give a seating capacity

It has been found by recent accidents, caused by broken axles on the Brooklyn Bridge cars, that it was necessary to shut off the current whenever an axle breaks before men could attempt to move the wreck, and the men were afraid to go near or to handle the wreck until the current was cut off. Every practical railroad man knows that accidents will happen; and that they generally happen at the place where they are least wanted. A friend of the writer once remarked when an axle broke in a freight train, just as it was passing an engine standing on a siding and piled a number of the following cars upon the locomotive: "I do not see why, with all out-doors to fall into, those cars should have fallen directly on top of that engine." But such is railroading, and the best-managed roads are liable to have broken axles or broken wheels at any time. With the electrical current introduced as another element, and with the entire line being depend-



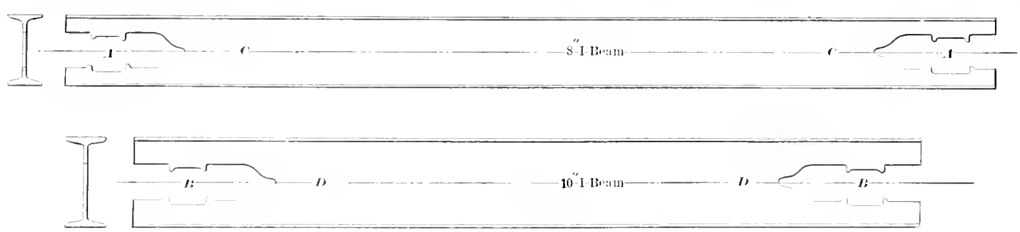
The Bettendorf I-Beam Bolster.

of 500 people, or 31¼ tons, allowing the same weight per passenger. This will reduce the weight of dead load per ton of passengers to one ton of passengers to three of dead load. Such a train as this with proper brake arrangements applied to all wheels, can be stopped much more readily than a heavier train, and with this amount of power and proper roller bearings, can be started with a 400 horse-power engine quite as quickly as a 240-ton train can be started with a locomotive, indicating 600 to 800 horse-power. Its greater carrying capacity would enable it to handle 1⅔ times the amount of passengers that could be handled by the heavier train.

The motor suggested is of such character and so arranged as to be entirely noiseless, smokeless and odorless, and to have no objectionable features that would prevent its passing over ordinary street car tracks in the streets of a city. Then the solution of the problem appears to be for the steam railways to build branches reaching their suburban business and bringing it to their main lines, and running these trains directly over their main lines to their terminals in the cities, and from the terminals on to special tracks which they can own and operate as street car tracks, leading directly into the heart of the cities, and such an arrangement is now contemplated by several leading lines.

ent on the continuous and uninterrupted action of this current, such accidents will be very annoying and dangerous.

The only other advantage of electricity over the steam locomotive, advocated by Mr. Davis, is, that the units of power would be lighter and that the pressure on the rail would be continuous, by reason of the motor being a rotary motor, and that the hammer-blow, of which he speaks as being caused by unbalanced reciprocating parts, would be done away with. On the motor that is contemplated to meet this class of business there are no unbalanced reciprocating parts, the motor being entirely balanced so that the pressure on the rail is the same at every part of a revolution and there is no jigging action of the car by reason of unbalanced parts; and the weight on the truck is no greater than it would be with electrical trucks for carrying the same load, and the motors being entirely spring-supported—there being no motor directly on the axle as the electric motor is carried—the action of the wheels on the joints will be very much less destructive than the electric motors. Every street railway manager knows that the electrical motor is not easy on the tracks or on the joints, and it has been found very difficult to keep the joints up on electrical railways. The weight of rails per ton is an evidence of this,



The Bettendorf I-Beam Bolster.

Returning to our discussion of Mr. Davis' paper. He advocates the introduction of electricity on suburban roads by a similar system to that described above, and also advocates that, in place of wiring the present lines of steam roads where this kind of business is contemplated, entirely new tracks should be laid parallel to the existing tracks. This would necessitate, of course, the introduction of the "third rail" system, because the new tracks would have to cross yards and other existing tracks, and would bring the uncertainty of the electrical current into the yards where accidents are always liable to happen. One of the bad features of the third rail system, which is not pointed out by Mr. Davis or any of the electrical advocates is, that by its introduction upon existing tracks the liability is always present of having the entire circuit broken by the tracks being torn up by a wreck, or having a short circuit under the wreck on account of an axle or any other piece of iron coming in contact with the third rail and one of the main rails. Such a condition of things would result in the whole line being paralyzed, and would be very likely to result in the wreck being burned; or if people were fastened in, of their being killed by the electric current.

many electric roads now being equipped with 80-pound rails; while, if steam railroads should resort to the same proportion of weight of rails to loads carried, their rails would have to be as heavy as 300 pounds to the yard.

As regards comparative cost of electrically equipped roads to steam roads as they now exist, Mr. Davis arrives at the conclusion that the additional cost of an electrical road over steam roads, is $51,367 per mile for conditions such as would be required for very heavy suburban traffic, and this is the only kind of traffic that has been discussed by him. As regards the cost of operation, he concludes as proven by statistics of electrical roads and steam roads, that, to carry a train of 60 tons at an average speed of 40 miles an hour, the electrical road must burn 48 pounds of coal per train-mile at the power station; while, with the steam train weighing 200 tons and traveling at an average speed of 20 miles an hour, only 58.8 pounds of coal per train-mile are required. This would give for the electrical road a movement of 2,500 pounds for one mile per one pound of coal, and for the steam road a movement of 6,802 pounds for one pound of coal, or nearly 2¾ times the amount of weight moved the same dis-

tance for a given amount of fuel. Now, as a fact, at this rate of speed—a speed of $11\frac{1}{3}$ miles per hour—we have moved cars weighing 75,000 pounds one mile for $2\frac{35}{100}$ pounds of coal on a steam road.

As regards the efficiency and coal consumption, as further stated by Mr. Davis, he gives $2\frac{1}{2}$ pounds as the amount of coal necessary to generate one indicated horse-power, at his power plant under the best conditions on an electric road, and then allows 90 per cent. efficiency for the engine, 90 per cent. efficiency for the dynamo, 80 per cent. efficiency for the line and 75 per cent. efficiency for the electrical motor, giving a combined efficiency of only 48·6 of the indicated power of the engine in the station, and states that the coal consumption for a horse-power actually developed on the motor would be 5·1 pounds, while he gives 5·5 pounds as being the average of steam railway locomotive practice in this country, stating that at times this latter figure will fall to $4\frac{1}{2}$ under the best conditions.

Now, while we are discussing new methods and new appliances to meet new conditions, why not consider the best that can be done by the steam motor? The writer has tested a number of locomotives that have been in operation for long periods, that have shown their ability to produce a horse-power, under average conditions of railway work, for three pounds of coal, and is willing to undertake to design and construct locomotives to-day that would do their work on $2\frac{1}{2}$ pounds of coal per horse-power per hour.

In regard to this question of the economical performance of the locomotive or steam motor, as against the electrical system, the writer would state that there never was a greater fallacy than the one that is being constantly circulated, to the effect that the locomotive is necessarily a wasteful machine, while the stationary plant for generating electricity is much more economical. That it is a fallacy is proven by Mr. Davis' own statements, quoted above. While $2\frac{1}{2}$ pounds per indicated horse power is given as the amount of coal necessary to generate one horse-power under conditions of an electrical generating plant, and while this is possible and entirely probable with a plant working under full load—as will a plant operating a street railway system, where a full load is maintained most of the time—under conditions of suburban and inter-urban work, where it became necessary to extend the interval between trains to a period of ten minutes, instead of a period of two minutes, or $1\frac{1}{2}$ minutes, as on street-car work, the electrical generating steam engine is working under the worst possible conditions for economy, and it is running more than half the time without load. During this time it is consuming a large amount of power without results, and the cylinder becomes merely a condenser of steam, and under these conditions it cannot be expected that an engine will indicate 1 horse power on $2\frac{1}{2}$ pounds of coal; but rather, under these conditions, it is most probable that an engine will use from four to five pounds of coal. The average electrical plant to-day—if we take the average in street railway work—will be found to be using more than $4\frac{1}{2}$ pounds of fuel per horse-power indicated in the station, and if we take 48.6 as the efficiency as stated by Mr. Davis, the motor will require more than 9 pounds of coal to be burned in the station to give one horse-power on the axle.

On the other hand, if we consider the steam motor under the conditions on which it would work in this kind of service we find that it is working under the most economical conditions that a steam motor or steam engine can work under; that is, it is giving a very high amount of power for a given amount of cylinder: the pressures are high and the cylinder condensation is low. As an instance, on a locomotive we have gotten as high as 1,810 horse-power out of a pair of 20 by 24-inch cylinders, with a heating surface of 1,848 square feet, or nearly a horse-power on every square foot of heating surface in the boiler, and 30 horse-power for every square foot of grate area, while if we were to design a stationary engine to indicate this amount of power we should put in a pair of 30 by 48-inch cylinders, which would necessarily have a much larger amount of cylinder condensing surface, and as cylinder condensation is well known to be one of the largest losses that a steam engine has to contend with, amounting to from 20 to 25 per cent. of the total steam used, we can readily see the importance of getting the most out of the least amount of cylinder surface. While some engineers have banked largely on the fact that with the stationary engine plant they might be able to use a condenser, it is found that by going to a high pressure and getting a great amount of power out of a small cylinder nearly the same results can be attained without the use of a condenser, and that with 200 pounds pressure and a properly designed compound engine a horse-power can be obtained for about 16 pounds of water.

On the steam motor we have under consideration 80 per cent. of the exhaust steam is condensed and returned to the tank from which the boiler is fed, only 20 per cent. of it being used for the blast, or to create the draft for the boiler. This, of course, insures hot water feed to the boiler, the absence of which in it itself is one of the largest sources of loss in an ordinary locomotive, as much as 22 per cent. of the heat being required to bring the water up to 212 degrees and feed it into the boiler with an injector as used on ordinary locomotives.

Another great source of loss in ordinary locomotives is that a large amount of fuel is consumed while the engines are not actively in operation and not doing work. The writer has known of as much as 1 ton of coal and nearly 2,000 gallons of water being used while an engine was standing on a siding waiting for a train. The old way, which is still in use on many roads, is for an engine to make a certain run and then go back to the roundhouse or on to a siding, where it is allowed to stand for many hours and cool down, or to keep steam up by constantly burning coal, and to blow steam through the safety valves, simply from the want of management on the part of the fireman and engineer, and on the part of the manager in allowing an engine which might be working to be sidetracked or put away, when she might, on local trains, take out another train at once, if not with the same engineer and fireman, with another crew.

The secret of economy, with any equipment, is to keep it constantly at work, only allowing such time to intervene as is necessary to coal, oil, clean and make necessary repairs. With such a motor as we are considering, and with electrical equipment, this is what is done. The cars are not allowed to remain idle, but are constantly in operation during the working hours and, of course, are earning money, and not deteriorating by reason of changes of temperature by cooling down and heating up again, as is done with ordinary locomotives in ordinary service. The motor we are considering is entirely automatic as to its fuel supply, and the fuel supply is cut off as the boiler approaches the blow-off point, and as the steam pressure decreases, the fuel supply is renewed, so that no heat is being generated unless there is work for it to do.

It is evident from Mr. Davis' figures that what he started out to prove—that is the economy of electrical equipment as against steam railway equipment—has not been proven, but that the reverse has been demonstrated. Few railroads are in condition today to consider the expenditure of $51,000 per mile for a single track, over that which would be necessary to build steam roads, or to build new lines to take the place of existing lines that can be operated by simply introducing new methods and new equipment that would cost less than the simple wiring of the lines for electricity.

The Bettendorf I-Beam Bolsters.

The bolsters shown in the accompanying engravings are made of rolled steel I-beams of the American Steel Manufacturers' specifications, the forms being the same as are used in steel bridge and building construction and the design admits of making light bolsters which are strong.

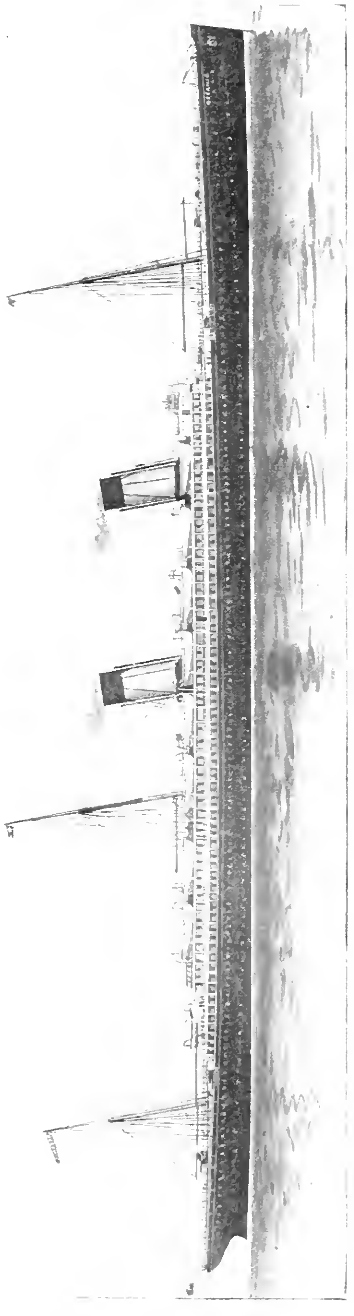
The construction is shown in the drawings. The web of the beam comes centrally under the load on the center plate. The I-beam is tapered or reduced by two processes. At the extreme end over the springs (marked *A* and *B* in the drawings) a section is cut out in such a manner that when it is pressed together the upper and lower parts of the web interlock firmly. At the same time the material from that point toward the center is corrugated or squeezed in, as shown at *C* and *D*. At the point where the portion is cut out and interlocked a butt weld is effected. From the center plate to the side bearings the full strength of the I-beam is obtained, and as the fibre is longitudinal it is not disturbed. The result of this process is that the bolster, when made up, stands about the same load under the testing machine that the two I-beams stand before the reduction of the web. In the body bolster the lower member is pressed upward, the upper flange remaining horizontal.

The weight of the body bolster is 350 pounds, and it is stated to be fully adequate for an 80,000-pound car. The weight of the truck bolster is 450 pounds, and it is also strong enough for any load that can be put upon it in service. In a test of the truck bolster, made by Robert W. Hunt & Company, of Chicago, March 30, 1897, it showed no permanent set after a load of 100,000 pounds, and under a load of 150,000 pounds it took a permanent set of only about one-quarter of an inch. The maximum load was 179,-800 pounds. In a test made at the works of the inventor it took a permanent set of only $\frac{15}{32}$ of an inch under a load of 180,000 pounds. It is further stated that when tested on its side it stood a load of 70,000 pounds with $\frac{1}{32}$-inch set, and at 80,000 pounds it took a permanent set of only $\frac{5}{32}$ inch. The body bolster, when tested by Robert W. Hunt & Company, showed a permanent set of only .02 of an inch under a load of 100,000 pounds. At 130,000 pounds the permanent set was 1.01 inches.

The parts of these bolsters are put together without the use of rivets, properly so called. Tubular rivets are cast on the malleable iron parts. They pass through and are expanded in the holes drilled in the steel for the purpose, and are beaded down like an eyelet. The result of this construction is that any strain upon one is borne by all the parts, and it is believed to be impossible to shear a rivet under any but extraordinary conditions. In case of repairs, all that is necessary is to cut off the eyelet with a cold chisel and insert a rivet. In case of a wreck, the bolsters can undoubtedly be repaired, as most of the parts could be used over again. Further information may be obtained from Mr. W. A. Smith, Old Colony Building, Chicago.

The White Star Steamship "Oceanic."

The announcement was made several mouths ago in these columns that the White Star Line had arranged with Messrs. Harlan & Wolff, of Belfast, for the building of a record-breaking steamship and it was stated that the vessel would be propelled by three screws. Through the courtesy of the *American Shipbuilder* we are able to present an illustration showing the general appearance of the ship when finished and the following is reprinted from that journal:



THE WHITE STAR LINE'S NEW TWIN-SCREW STEAMER OCEANIC. BUILDING BY HARLAN & WOLFF, BELFAST, IRELAND.

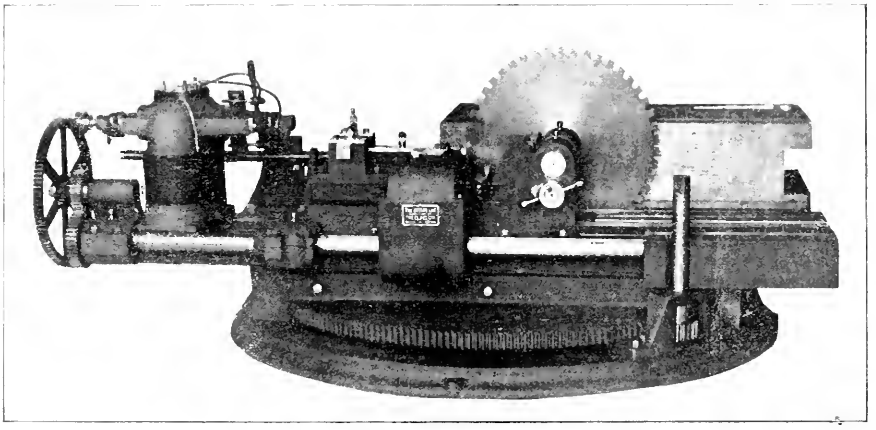
"It would be a pleasure to be able to announce that the gigantic steamer *Oceanic* was to be propelled by triple screws, as George W. Melville, Engineer-in-Chief of the United States Navy, has done so much to bring about the triple screw system in ships of war—the *Columbia* and *Minneapolis* being so fitted—and is anxious to see it adopted in merchant steamers: but, notwithstanding published reports in several of the marine and mechanical journals of Great Britain and the United States that the *Oceanic* would be driven by triple screws, we must now put to rest such a theory by stating that the *Oceanic* will be a twin-screw steamer. The supposition that the vessel was to be a high-speed craft with engines of 45,000 or 50,000 horse-power probably influenced our British and domestic contemporaries in stating that three screws would be used. What the power of the engines is to be the owners and the builders do not care to say at this stage of the construction. But we can state positively, upon the authority of H. Maitland Kersey, that triple compound engines will be used, and not quadruple expansion engines. The theory that it might not be safe to transmit more than 20,000 horse-power through one shaft, gives rise to the belief that the combined engines will not indicate more than 40,000 horse-power and it is surmised that a speed of not more than 21 or 22 knots can be obtained from that power. Indeed, some engineers doubt if over 20 knots can be developed in the *Oceanic* if the engines are not capable of more than 40,000 horse-power. Be that as it may, the *Oceanic* will be the most magnificent as well as the largest steamship afloat, being larger than the *Great Eastern*, as will be seen by comparing the figures.

The *Oceanic* will be 705 feet long, 685 feet on the water line, 68 feet beam, 50 feet deep, 27 feet draft, and 17,000 tons, gross. The *Oceanic* will be launched in January and is expected to be ready to make her first trip to New York in the following June. Next to her great size, the most striking feature in the new ship is the fact that no special effort will be made to surpass all previous records in the matter of speed. Hitherto, it is safe to say, speed has been made the first consideration, and to this all other elements, such as carrying capacity, comfort and economy, have been made strictly subordinate. Now, of all the features that go to make a first-class Atlantic passenger ship, speed is by far the most costly, and when it exceeds 20 knots an hour, the most doubtful in its utility. The enormous sacrifice at which high speed is obtained is proverbial. The *Oceanic* will be an enlarged *Majestic*. She will have two elliptical funnels, three masts and the twin screws will overlap, the starboard shaft extending further aft than the other to give clearance for the propellers. The shafts will be carried out in a spectacle frame, an arrangement in which the plating of the ship is built out and around the shaft, forming a tubular protection which extends up to the stuffing box gland, and allows the shaft to be inspected at all times. A long turtle deck will extend from the bow aft for over 150 feet. The dining saloon will be placed amidships, and above it will be an unusually large and handsome library. Altogether, provision will be made for carrying 350 saloon passengers with such surroundings of comfort and luxury as have never been attempted before, and the provisions for the other classes of passengers will be on a similar scale. In closing, we may say that the *Campania* has engines of 30,000 horse-power and has developed 22 knots an hour. She and her sister, the *Lucania*, have the most powerful engines afloat.

An Electrically Driven, Bryant Cold Saw.

The general appearance of a newly designed cold metal, sawing machine of the Bryant type which has just been brought out by the Q & C Company is shown in the accompanying engraving. This machine is known as the "No. 15," and it is mounted upon a circular base and is adapted to be driven by an electric motor. The arrangement was made with a view of the requirements of structural iron and steel work such as bridge building, and for any work in which beams, channels and angles are used. It is adapted to general work also, and has a large capacity, the lead-

ing idea in the design being to furnish large capacity for a low cost. This machine contains several improvements, among which are increased feeding speeds, prolonged life of saw blades and lateral adjustment of saw blades. The feeding mechanism has been much improved, and the change can be made from slow to fast, or *vice versa*, without stopping the machine. The saw carriage is provided with quick return operated by a rack and pinion. All bearings are adjustable to compensate for wear, and the machine throughout is made of the best material. The saw arbor is of Jessop steel and the worm wheel of phosphor bronze engaging with a steel worm.



The Bryant Cold Metal Saw.

The engraving shows the method of attaching the motor, and the machine is also furnished on a stationary base with tight and loose pulleys for direct belt power. The weight of the machine is 7,000 pounds. A three horse-power motor is required to run it and the speed of the driving shaft is 140 revolutions per minute, while that of the saw is $3\frac{3}{4}$ revolutions. The feeding speeds are $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$ and 1 inch per minute. The saw arbor is 3 inches in diameter and the driving shaft is $2\frac{1}{4}$ inches in diameter. The sprocket is of cast steel, diameter $6\frac{1}{2}$ inches. There are two work tables, the upper one being 20 by 48 inches and the lower one is 22 by 18 inches. The capacity on solid work at all angles is 24 by 10 inches and the horizontal travel of the saw is 28 inches, the available diameter being 10 inches above the upper table. Saws of a thickness of $\frac{1}{4}$ inch are used and an adjustment is provided for the sprocket for taking up a wear of the saw amounting to 6 inches. The base swivels 90 degrees and is operated by a segmental rack and pinion. Each machine is accompanied by two saw blades, a grinder, an oil pump for lubricating the saws and the usual tools for adjusting the machine.

The machine is well adapted to sawing out frogs and switch-points and similar work in connection with track construction. The street railways have found the machine to be very useful in track work and it is equally well adapted to the handling of the rails of steam roads. The manufacturers may be addressed at the Western Union Building in Chicago, and at 100 Broadway, New York.

The Westinghouse High-Speed Brake.

A copy of a new publication entitled "The Westinghouse High-Speed Brake" has just been received from the Westinghouse Air-Brake Company. It is a valuable addition to the literature of the air-brake and describes the newly-developed apparatus for application to high-speed trains. This improvement will form the subject of an illustrated article in the August number of this journal. The new apparatus is a distinct advance in the art of air braking. It has been designed to meet the exceptional requirements of regular trains which are scheduled to run at much higher average rates of speed than have heretofore prevailed in passenger train service. The high-speed brake is designed to stop passenger trains in emergencies in about 30 per cent. less distance than is required with the best brakes heretofore used. The brake apparatus employed to do this is of the standard Westinghouse quick action type, with a pressure-regulating attachment. The addition of this latter device, to the existing quick-action brake for locomotives and cars is all that is required to convert them into high-speed brakes, and the superior stopping power is obtained by increasing the standard air-pressure of 70 pounds to about 110 pounds and taking advantage of a well-known principle in braking.

The Great Siberian Railroad and the Present State of Its Construction.

(Special Correspondence to the *American Engineer, Car Builder and Railroad Journal.*)

(CONTINUED FROM PAGE 175.)

IRKOUTSK-MISOVSKAIA.

The connection of Irkoutsk, the terminus of the Central Siberian Railroad, with the harbor Misovskaïa, the starting point of the Transbaïkal Railroad, was originally designed as a continuous railroad, the Baïkal loop line. But as the preliminary surveys of this Baïkal loop line, along the south shore of Baïkal Lake, has shown that the construction of this line will be very difficult and require much time, and that more accurate surveys are necessary. It was decided in order to obtain the continuous steam connection between Chelabinsk and Vladivostok to build the branch from Irkoutsk to Baïkal Lake, and to arrange for a steam ferry across the Baïkal Sea.

The construction of the branch from Irkoutsk to Listviniehnaïa, a landing place on the west bank of Lake Baïkal, along the left shore of Angara River (43 miles), was endorsed by the Emperor in June, 1896. The construction will be completed in autumn, 1898; it will cost (without rolling stock) $1,264,000. The work began in August, 1896, and without doubt it will be completed in the assigned term.

In order to carry out the plans for the steam ferry across the Lake Baïkal, it was necessary to build two harbors on the western and eastern bank of the lake, to buy an ice-breaking steam ferry for the transportation of whole trains, and to build one wooden floating dock.

The cost of ferry, harbors and dock is estimated at $1,687,000. All this work will be completed in autumn, 1898.

The ice-breaking steamer has been built by the Armstrong Works, in England (for £70,000); it has 4,200 tons displacement, the length is 290 feet, width 57 feet, and greater draft 20 feet. The

engine is of 3,750 independent horse-power. The upper deck bears three pairs of rails, which can carry 20 cars. The steamer is already completed and in small portions is being carried to Krasnoiarsk. From there it will be transported to Lake Baikal, and put together in the wooden floating sectional dock.

In order to have a more exact idea on the natural conditions of the Lake Baikal, exact meteorological observations have been made. These observations, made in Misonskaia, on the eastern bank of the lake, gave the following results:

The ice began to form in the middle of December; its thickness was two inches. The thickness of ice gradually increased, and in the middle of January, when the whole surface was frozen, it was 12 to 16 inches. In the middle of the lake the thickness of ice was less and the layer of snow was thicker. A sledge road was established in the second half of January, when the thickness of ice was 12 to 16 inches. The 30th of January it had reached 16 to 20 inches.

The greatest thickness of ice was 3 feet in the end of March, after which the thickness of ice decreased. The eastern half of the lake (from Misovshaïa to the middle) was covered with snow about 10 inches thick, and the western half (from Listvenichnaïa to the middle) was more or less free from snow.

The surface of the ice in different parts of the lake and in different directions shows fissures, the wide of which reaches 10 feet. These are sometimes covered with inclined ice blocks 3 feet high, or with horizontal blocks 20 feet wide. The greatest number of fissures occurs in March.

The average monthly temperature of the lake in February (— 15.4 degrees C.) was something lower than on the shore; in Misovskaïa (— 14.1 degrees C.), and in Listvenichnaia (— 15.1 degrees C.). The minimum in the middle of the lake was —24 degrees C. February 25; maximum, 5.5 degrees C. February 17. The greatest amplitude of variation was in February 18.6 degrees, in March 26.4 degrees, and in April 22 degrees.

The temperature of the water near the ice was very stable (variations $\frac{1}{4}$ — 1 degree C.); at depths of more than 35 feet the water had during the whole winter the constant temperature $3\frac{1}{4}$ degrees C.

The clearing of Baïkal begins at the western bank (Listvenichnaïa) and then at the eastern shore (Misovshaïa). The first trip of the steamer was made May 12, and May 22 the ice had disappeared.

In consequence of this it is expected that the trains could be transported across the Lake Baïkal by the ice-breaking steam ferry during 10 months in the year. The remaining two months the trains will be carried on tracks laid over the ice.

The surveys and location of the Baïkal loop line was designed in 1894 and a sum of $107,500 was appropriated. The survey was commenced in 1896 and will be finished in 1897. The construction of this line is still a question of future time. The length of the line is 161 miles, the ruling gradient 0.018 (1.8 per cent.), minimum radius of curve 840 feet, and a tunnel 13,800 feet long shall increase the cost of construction.

THE TRANSBAIKAL RAILROAD.

The Transbaïkal Railroad, according to its final location, has the following length:

From Misovskaia on Lake Baikal to Sretensk on Shilka River...	$687\frac{1}{2}$ miles
From Sretensk to Pokrovska...........................	241 "
	$928\frac{1}{2}$ miles

The preliminary surveys were made in the years 1887 and 1888; the definitive location in 1893 and 1894, and the line is located, as before, along the Khilok River.

The cost of the first division from Misonskaïa to Sretensk, together with rolling stock, is estimated $33,010,009 or $43,780 per mile. The second division probably shall not be built next time.

The construction of the Transbaïkal Railroad was commenced in 1895 and at the end of 1896 the progress of works was represented by the following figures: 11,430,000 cubic yards of earthworks completed, or 50 per cent. of the whole; 32,450 square yards of pavement of grading slopes: 84,000 cubic yards of retaining walls: 273 miles of provisory roads: 9 miles of horse roads; 81 provisory buildings and 14 dynamite stores are constructed, and 30,000 tons of rails are shipped. Besides them there are in construction 8 stone culverts, 56 timber bridges, 21 temporary timber bridges, 50 stone bridges with timber girders, 8 stone bridges with iron girders and 4 great bridges. The track is laid on four miles only. There are in construction 8 watchmen-houses, 56 small section houses, 48 great section-houses, 20 wells, 19 passenger-houses, 6 engine sheds, 1 small repair workshop and the great repair workshop in Chita, 74 houses for employees, 5 water stations, 1 pumping-houses, 1 hospital, 3 storehouses, 3 blacksmith shops, 26 wells for station water supply. The telegraph is ready on 400 miles. Many provisory houses for workmen and workshops are built; 157,000 ties are prepared. The number of different workmen is 14,300, and there are 1,078 horses.

In order to supply the Portland cement for the stone-work of the Transbaïkal Railroad, two cement works have been constructed in the country: the Kokyrtaïsk works and the Briansk works. The first of these works, near Nerchinsk, will manufacture 40,000 barrels yearly, and the second, near Werkne Oudinsk, 20,000 barrels yearly. Both works have received a government order of 300,000 barrels in five years, at the price of $8 per barrel. The works near Nerchinsk were ready in autumn, 1895, and the manufacturing of cement then began; the works near Verkne Oudinsk are now ready and the manufacture of cement is just begining.

The construction of the Transbaïkal Railroad is carried on with great energy, but it is very difficult to complete the track-laying in the designed term, viz., 1898; for the reason that the transportation facilities of Amour navigation companies are not sufficient for carrying all the necessary materials.

Having in view the scarcity of habitations in this country, the administration of the railroad contemplates building, near the Chita workshops, a settlement for workmen, consisting of 70 small houses, each of four or two tenements.

(To be Concluded.)

The Acme Bolt Cutter.

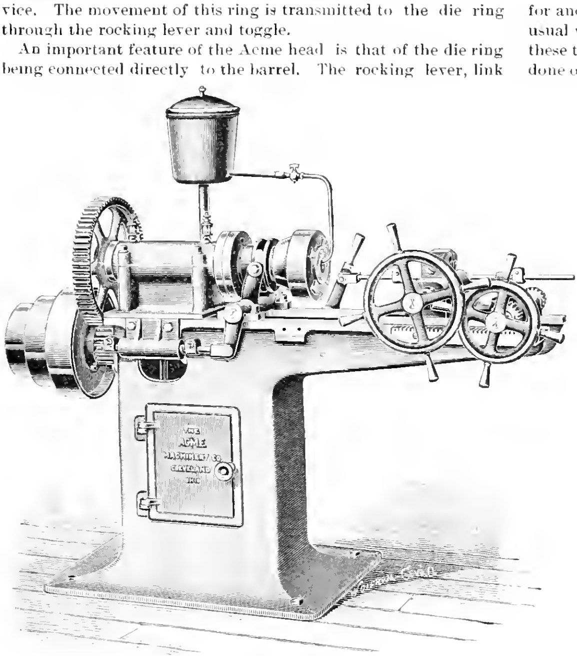
The accompanying engravings illustrate the general appearance of two forms of the Acme bolt cutter, one of them being new. These cutters employ four dies in a set, each having a solid end bearing. They are of market size tool steel and are carefully ground to standard gages and are made to fit hardened tool steel bushings in the head of the machine. Being simple in form they may be made in any machine shop and by any mechanic of ordinary ability. The cutters are furnished in sizes from $\frac{1}{4}$-inch to $1\frac{1}{2}$ inches, inclusive. The dies furnished by the company are all provided with hardened tool steel caps made on the interchangeable system and the caps may be used over and over again with new dies.

The machine first shown is of the single head type. They are also made with double and triple heads, and single headed machines are made of sufficient power to cut threads as large as six inches in diameter. The matter of lubrication has been carefully considered in this design. The spindle which carries the cone pulley at the left of the machine has a crank pin on its inner end, within the hollow base forming the support to the machine and a small reciprocating oil pump is driven by a connecting rod. The position of the crank pin with reference to the center of the shaft is adjustable whereby the stroke of the plunger may be varied to govern the amount of oil delivered. The base of the machine is solid at the bottom, forming a receptacle for the oil to prevent its loss. The discharge pipe is carried upward into the oil pot through the center of the overflow pipe; its end is conveyed downward and falls slightly below the top of the overflow pipe, thus preventing the splashing and churning of the oil. The pump is of ample size, so that when running with a slow speed plenty of oil is supplied to the cutters. With this lubricating arrangement the machine may be kept as clean as any lathe.

The "Acme Head" supplied with these bolt cutters is composed of but three parts, the barrel, the die ring and a clutch ring. The barrel is made of cast iron, turned, milled and bored perfectly true. To the front end is fastened a face plate which serves to hold the dies and die bushings in place. In the outer surface of the barrel there are four longitudinal grooves milled to within a short distance of the flange, and in these grooves are fitted tool steel strips hardened and ground to resist the wear of the sliding die ring. These strips are fastened to the barrel with screws, so that even after years of service all wear between die ring and barrel can be taken up. The die ring is made of cast iron, the inner surface of which has tool steel strips hardened and ground to correspond with those in the barrel. This ring controls the movement of the dies radially to and from the center, by means of recesses, milled at an angle of 15 degrees from its face. The bottoms of these recesses are lined with tool steel to resist the wear of the hardened steel die caps. The clutch ring is made of cast iron, having an annular groove to receive phospher bronze seg-

ments that are attached to the automatic opening and closing device. The movement of this ring is transmitted to the die ring through the rocking lever and toggle.

An important feature of the Acme head is that of the die ring being connected directly to the barrel. The rocking lever, link



The Acme Bolt Cutter

and adjusting screw form this connection in a very efficient manner. When the head is closed the middle center of the toggle passes below the end centers $\frac{1}{100}$ of an inch, and does not affect any movement of the die ring in so doing. But it forms a lock which cannot yield to any pressure produced in cutting threads. The adjusting screw is made with a fine thread so that bolts may be cut to the exact size required, and when adjusted, it is clamped firmly in place by means of a threaded bushing. All heads are supplied with an index, and when a record is kept of the dies, the head may be set to cut the required size without the necessity of making several cuts. The construction is simple, making it easy to adjust and operate, and all moving parts are so arranged that it is impossible to clog with chips and scale.

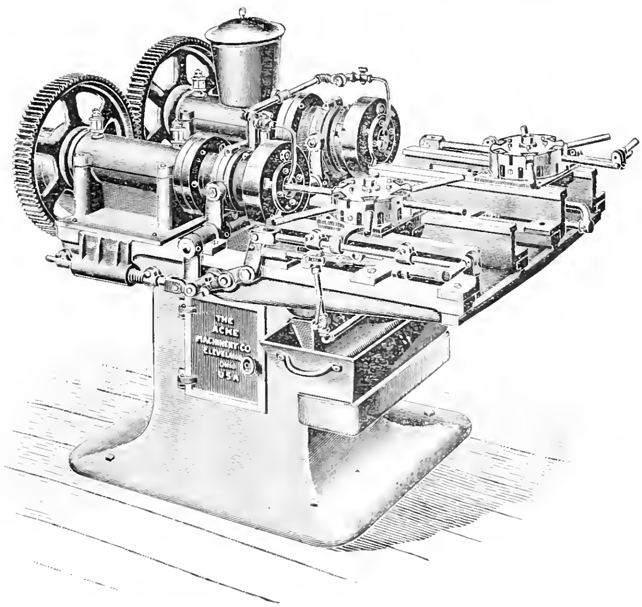
An interesting improvement in the form of a pneumatic turret attachment to these machines is shown in the second engraving. This is the invention of Mr. H. A. Fergusson, Assistant Master Mechanic at the Meadows shops, Pennsylvania Railroad. This attachment, which consists of a turret revolving on a slide, may be easily removed and replaced from the machine in a few minutes, and it may be applied to any machine of this company's make. It is operated by compressed air from a small supply pipe under the bed of the machine. The turret has spaces for six bolts, and the entire duty of the operator is to keep the spaces filled, since a small cylinder under the slide does all the rest, ejecting the bolt when it is cut, closing the dies, and revolving the turret presenting a new bolt.

The construction of the turret is such that it can be rapidly set for another size of bolt, the machine otherwise being set in the usual way. The amount of work that can be turned out by using these turrets is stated to be more than twice as much as can be done on other machines, and with less exertion by the operator.

One of these machines was exhibited at the recent conventions at Old Point Comfort, from which it was seen that the workmanship throughout was of the best, and of a quality that will undoubtedly insure long wear of parts.

These pneumatic turrets are designed to increase the rapidity with which bolts may be cut, not by altering the speed of the die heads, but by reducing the time taken to close the dies and remove and replace the bolts, their action being entirely automatic, each bolt being ejected and a blank started in a fraction of a second. It is stated that $\frac{5}{8}$-inch bolts have been cut with it at the rate of 800 per hour, the machine having cut 7,200 bolts of this size in 9 hours running, the work done being good.

The machine is a decided novelty and seems to be designed upon good principles of mechanics as applied to such work. The use of air pressure has two specially good features. It offers an elastic push of the bolt which is yielding if a heavy resistance is met and it assists the dies in relieving them of the necessity of drawing the bolt along while cutting. A spring backing to the head of the bolt prevents shock when the bolt touches the dies. It may be said that this machine is an important improvement over others in output and that no sacrifice of quality of work is made, the product being fully as good as that by the old method.



The Acme Bolt Cutter, with Pneumatic Turret.

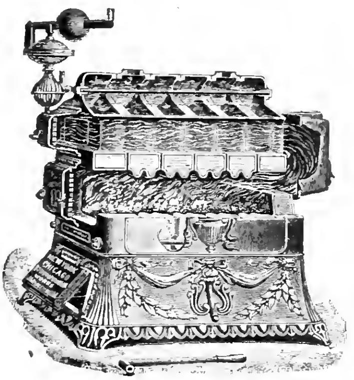
The Latest on Tonnage Rating.

Experiments have recently been carried out by Mr. S. P. Bush, Superintendent of Motive Power of the Pennsylvania Lines, upon the effect of varying the number of cars in trains and the weights of trains. It was found that the generally accepted opinion was true that the variation of the number of cars with a con-

stant weight of train had a greater effect on the fuel consumption of the locomotive than does a change in the weight of the train. The experiments were conducted on the line between Logansport, Ind., and Chicago, a distance of 115 miles, and they were divided into two series, the first of which employed trains of equal weight, but varying number of cars and the second used trains of equal numbers of cars, but varying in weight. The tests on trains of the same weight but variable number of cars showed that the fuel consumption increases uniformly with the increase in the number of cars. When the trains were composed of equal numbers of cars, but variable weight the results were not regular and uniform, but it was evident that the consumption of fuel for any given number of cars was comparatively constant no matter whether the cars were lightly or heavily loaded. In one instance an increase in fuel consumption of only about 400 pounds was found with a 32-car train, when the load was increased from 750 to 1,050 tons. The conclusion reached by Mr. Bush was that as a result of this information it is easily seen that, under the conditions existing on this particular division, an absolute car-mile basis counting each car as a car, whether loaded or not, and making the necessary adjustment of the weight, would be more accurate than to rate engines upon the tonnage system. He believed that the car basis was better for practical purposes of rating locomotives than the tonnage system, and that for all practical purposes the weight could be left out of account entirely.

The Bundy La Villa Heater.

In appearance the Bundy La Villa Heater savors of stove construction inasmuch as it is quite ornamental. It is designed to be placed in a living-room for direct heating and other rooms may be warmed by radiators connected with it. In this manner small railway stations may be cheaply and efficiently heated. The



The Bundy La Villa Heater.

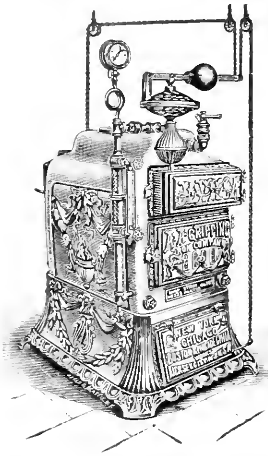
heater may be placed in one waiting-room and radiators in the other and in the ticket office.

The heater is made for both steam and hot water heating, and there are fourteen sizes of each. It is not designed for large buildings, the capacity ranging from 150 to 700 square feet for steam and from 200 to 1,050 square feet for hot water heating. It has an easily operated rocking and dumping grate, placed over an ash pit of ample depth, in which an ash pan may be and usually is used, especially where the heater occupies a living-room.

The fire pot has a corrugated crown sheet and sides whereby the direct fire surface is increased threefold. The products of combustion pass three times the length of the heater through water backed surrounding flues, thereby insuring thorough absorption of the heat for economical fuel consumption. The heater will burn either hard or soft coal, coke, wood or gas. It may be easily cleaned and by opening the front and rear clean-out doors every part of the heater is accessible. All doors are fitted and machined gas and dust-tight. When the grate is shaken all openings are closed as the shaker arm protrudes and no dust, smoke or ashes can escape. The heater is low, only 52 and 60 inches high for the two series. The base extends under the entire heater and it may safely be placed upon a wooden floor. The ashes may be removed in the ash-pan, causing no more dirt than the ordinary stove and the quality of the heat is healthful. The temperature is always under absolute control, is easily regulated, being automatic and according to the manufacturers the heater should last a lifetime and save enough fuel in its economical consumption to pay a very handsome interest on the investment.

This heater has a direct and indirect smoke connection with controlling dampers attached to the automatic regulator. All doors are lined to prevent warping and care and consideration has been given to insure perfect manufacture.

The attention of railroad officials is called to the advisability of using this heater, for while price is not the selling argument, still the cost is very low, and its durability one of its strong



The Bundy La Villa Heater.

claims, so that the placing of this apparatus is believed to practically solve the question of heating every station so equipped.

Further particulars will be given by the manufacturers, the A. A. Griffing Iron Company, 66-68 Centre street, New York, or at their distributing stores and works at Boston, Philadelphia and Jersey City, N. J.

Improved Pressed Steel Brake Shoe Key.

A newly improved pressed steel brake shoe key has just been introduced by the Q & C Company. Pressed steel keys of the Master Car Builders' type were formerly manufactured by the Drexel Manufacturing Company, and the improvement made by the present manufacturers consists in strengthening the key at the point at which it is subjected to the greatest strains, as shown

A New Brake Shoe Key.

in the accompanying engraving. With this improvement the only objection which has been raised against the pressed steel key is believed to have been removed, and while this is much lighter than a forged key it is strong and elastic. The material is a good quality of steel well adapted to the purpose and to the method of manufacture. The price of these keys has been reduced which constitutes an additional advantage to be derived from their use. The address of the Q & C Company is 700 Western Union Building, Chicago, and 100 Broadway, New York.

The Cloud Metallic Truck.

The form of truck which is illustrated in the accompanying engraving is the invention of Mr. John W. Cloud, who is well known to the readers of this journal. The truck is built entirely of metal, of steel and malleable iron and the object of the designer was to produce a truck which should be an improvement over earlier forms. The side frames are of plate steel and the pedestals are of malleable iron riveted to the frames. This construction permitted of placing the springs over the journal boxes. The frames are so arranged as to also permit of the use of elliptic springs which may be placed over the boxes with equal facility. When elliptic springs are used they are placed upon the box with the side frames between them and the pedestal casting comes down to within two inches of the top of the box. It will be seen that the construction followed reinforces the ends of the frames at the points where the strain from the boxes comes.

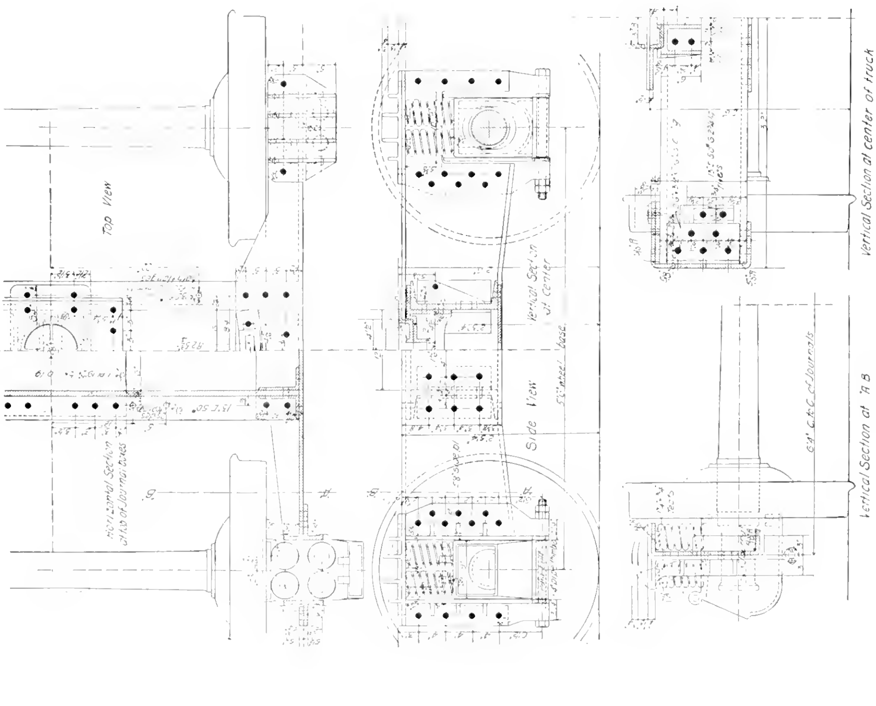
Four coil springs are used, which was considered to be an improvement over the use of one heavy double coil spring, and the use of the four springs tends to distribute the load evenly on the boxes and to keep them perpendicular without causing a tendency to bind in the pedestals. When elliptic springs are used the form of pedestal is slightly modified to receive them. These may be of any desired length and they may be designed for the special service expected of them. The method of placing the elliptic springs will be understood from the drawing which shows the method of attaching the coil springs.

Special attention is called to the form of the side frames and to the provision for the strains which come at the line *AB* in the plan and side views. The bearing of the pedestals against the boxes is 6 inches in width, which is wider than that provided in other forms of metallic trucks. Aside from the assistance which this will give in keeping the trucks square, the wide bearing will give a good wearing surface. The pedestals are secured at the bottom ends by "I" bolts, which are double-nutted and cottered. The proper distance between the jaws is maintained by the use of pipe thimbles.

One of the claims made for the design is that the side frames being flanged on straight lines permits of repairs being made at any shop and without requiring special tools, should they become bent or twisted in wrecks. It will be noticed that the beam for carrying the load is straight on its top, for which special advantages are expected. The transoms are made of rolled channels or of pressed steel plates in the form of channels. The center plate and side bearings are shown made of malleable iron, although pressed steel could be used for these if desired. For trucks with inside-hung brakes, malleable iron brake hanger brackets are riveted to the transoms. The transoms and side frames are united and thoroughly braced by gussets formed by the top and bottom flanges of the side frames. By referring to the drawing it will be noticed that the stiffness of the truck with reference to resisting the tendency to get out of square has not been neglected, the flanges of the side frames having been made wide at their points of contact with the transoms, and in addition to the riveting of the transoms to these flanges, angle attachments are made against the webs of the side frames. It is understood that tests have been made of the trucks, and that results were entirely satisfactory. Further information with regard to these trucks may be obtained from The Cloud Steel Truck Company, 1525 Old Colony Building, Chicago.

During the past 10 years the South has made rapid progress in supplying iron to the trade of this country and Europe. A contemporary points out that it was only a dozen years ago that the first shipment of Southern iron was made to Pennsylvania. At the time it created no small amount of surprise, for it was never believed prior to that time that the South would sell iron in the Keystone State. Statistics on this point show that shipments for April, this year, amounted to 101,141 tons. Of this the West took 38,207 tons, the East 29,996 tons and Europe 32,838 tons. Shipments to Europe so far this year amount to more than 100,000 tons, more than double the amount exported last year. It is expected that total shipments abroad for this year will be more than twice the amount sent last year.

All of the piping of the heating apparatus of the new Congressional Library at Washington, D. C., is covered with Keasbey & Mattison's magnesia sectional covering.



THE CLOUD STEEL TRUCK.

(Established 1832.)

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

28TH YEAR. 66TH YEAR.

PUBLISHED MONTHLY

BY

R. M. VAN ARSDALE,

MORSE BUILDING......................................NEW YORK

G. M. BASFORD, Editor.

JULY, 1897.

Subscription.—*$2.00 a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union.*

Subscriptions for this paper will be received and copies kept for sale by the Post Office News Co., 217 Dearborn Street, Chicago, Ill.

EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Special Notice.—*As the* AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL *is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 25th day of each month.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* **When a subscriber changes his address** *he ought to notify this office at once, so that the paper may be send to the proper destination.*

The paper may be obtained and subscriptions for it sent to the following agencies: **Chicago,** *Post Office News Co., 217 Dearborn Street* **London, Eng.,** *Sampson Low, Marston & Co., Limited St. Dunstan's House, Fetter Lane, E. C.*

Last year the new interchange won the day without a vote by cars and this year the whole of the work of revision concerned what may be considered minor details, with the exception of placing the responsibility for wrong repairs upon the people who make the wrong repairs. The good work of the railroad clubs was apparent throughout the discussion.

The compound locomotive had everything its own way in the discussion this year. The reports of saving effected were reasonable and entirely favorable to the compound type, but it appears that there are great differences between different compounds, and that the proportions of the cylinder volumes may affect the records between various compounds as greatly as the compound records differ from those of simple engines. The laboratory tests at Purdue will be likely to throw further light upon this feature of compound practice in the coming year.

It is easy to pass a resolution in a convention for the purpose of expunging from the printed proceedings anything that may appear to cast a reflection upon the organization. If a standard of one of the associations is ignored by a committee in making its report, it may not look well to have the discussion of its shortcomings printed for permanent record. But how does such a dodge look to a man outside of the membership? Perhaps if these things were placed upon permanent records the authors would be brought to see the value of consistency and in the end less would be heard about the disregard of standards.

A most sensible step with regard to the interchange rules was taken at the recent conventions in putting a stop to the bother which has been had with small bills. This is referred to elsewhere in this issue and along with the action looking toward a simplification of the work of the arbitration committee this must be considered an important improvement. There is another step, however, which might well be taken which consists of the establishment of a clearing-house for interchange repair bills, the purpose being to further simplify the business of setting the repair accounts. The clearing-house plan is being most successfully used between different roads of system lines for the saving of book-keeping and it would appear to be worth looking into with reference to use in the manner suggested.

The steel car has made material progress since the 1896 convention, and at Old Point Comfort last month the question was not as to the advantages of steel over wooden cars, but was: What kind of steel car shall be used? The exhibition of new pressed steel cars attracted much attention and favorable comment, while the Norfolk & Southern pioneer steel car, which has been in use several years, interested those who were concerned with the question of tightness of joints after rough service. In the discussion it was plain that entirely new methods of construction must rule, and the old ideas of trussed frames must be left with the wooden car. The steel girder needs no trussing for spans the length of a freight car, and herein is an advantage of steel construction in avoiding the use of truss rods. The plan of appointing individual members to present designs for steel cars worked well, and that the question involved in this field of designing must be decided by practical experience was made clear by the absence of discussion or of criticism of the plans presented, beyond bringing out the fact concerning trussing just referred to. There is also ground for hope that progress has been made in the direction of standardizing the chief dimensions of cars.

Grade crossing accidents with such consequences as attended the one which occurred at Valley Stream, Long Island, May 31, serve to call attention in a very forcible way to the fact that a large majority of the crossings at grade between streets and steam railroads are unsafe, and are sure sooner or later to become scenes of disasters more or less serious according to circumstances. In the case mentioned a coach load of people was struck by a train and five of the occupants were killed and several were injured. The crossing where the accident occurred was not more dangerous than a vast number of others, and the precautions for the prevention of accidents were not entirely neglected, since automatic bells were provided to give warning of the approach of trains. The public is naturally shocked by disasters of this kind, and severe criticism is poured out upon the management which neglects to make such horrors impossible. As a broad proposition it may be stated that no railroad should be allowed to run trains until every known precaution for the safety of the public and of passengers is taken. It is well to consider, however, what this means to the roads. The worst accidents may occur at the best protected crossing. There is nothing short of absolute separation of the grades that will provide immunity from such occurrences and the expense of this in crowded districts is enormous. It is fair, then, to ask whether after all the public itself has not some responsibility in the matter. There are very good reasons why the roads should be relieved of some of the immense expense of track elevation, and the example of at least one State should have an influence to raise the question as to whether the public is doing its share in the protection of itself.

SELECTION AND ENCOURAGEMENT OF SUBORDINATES.

During the past year the necessity of filling the position of president of a large railroad and of chiefs of important departments of several other roads has offered an excellent opportunity

to obtain an idea of the methods of organization which have developed in various companies. The differences in policy with regard to succession in office are remarkable. The death of the high officer referred to recently caused an advance all along the line, reaching even to some of the subordinate positions. Apparently, in this case, no thought was given to any outsider for filling any position which became vacant through the succession. There is good reason for the succession within this company's own staff of officers, in that the subordinates were fitted for promotion and were prepared for the assumption of larger responsibilities.

The manner of filling vacancies at the heads of departments on several other lines at about the same time was in marked contrast to this method, from the fact that men who were thought competent for the positions, and who were qualified to assume the duties, were not available on the roads. They were sought elsewhere and were placed in charge of men to whom they were perfect strangers. They were also unaccustomed to the methods and the special conditions under which these roads were operated. A thoughtful glance at these two methods of filling vacancies must result in strongly favoring the first, or succession from the ranks. It is not necessary to give undue or unwise consideration to seniority, because fitness for promotion would appear to be the fundamental reason for advancement.

It is said that it is advisable to import or introduce "new blood" occasionally in order to obtain the benefit of new ideas and to avoid drifting into ruts, but the deepest ruts are those into which subordinates run when their hopes for advancement are cut off by a policy of importing heads of departments to be placed over them. The encouragement of certain promotion as a reward for good work seems to be the best rut eradicator which has been brought out. This subject involves the question of the proper treatment of subordinates, even to the lowest, and that chief is likely to be most successful who understands and practises the art of getting the best and most intelligent efforts from all of the force for which he is responsible. The more responsibility an officer has the more he needs advisers, and is not the best adviser one who is in training to take his chief's position?

The chief who selects his assistants with reference to their fitness to succeed him will benefit by his own broadness of mind. He must profit personally because of the incentive which is offered him in keeping ahead of his subordinates, and as they improve he must improve and become more valuable to his superiors, and therefore better qualified for his own advancement. It is believed that many men defeat their own object of promotion by their management of their immediate subordinates. Proper credit and encouragement to these, added to careful selection, would probably be found as advantageous to a man's reputation as the adoption of a carefully developed standard in any branch of operation or construction. A standard method of encouraging education and improvement would be worth formulating.

Technical organizations among men in railroad service are growing in favor, and while railroads are not expected to enter educational fields in general, much may be accomplished by education along the lines of the peculiar problems with which each particular road is confronted. The organization of the employees of a department of one of the most progressive Western lines, which is built upon the following liberal "platform," offers an excellent example of a legitimate and satisfactory educational institution which incidentally furnishes great encouragement to the men.

"No monopoly of knowledge.

"No concealment of ignorance.

"The company is entitled to all the information about its work and business that is possessed by any employee.

"Every proposition or suggestion from an employee intended to promote safety and economy is entitled to respect, and will always receive consideration.

"Employees are trustees for the stockholders.

"We are known individually and collectively by our work."

It is evident that it will not be necessary to import a man to succeed the head of that department, and the principles so tersely stated in this platform are worthy of the most careful consideration and of adoption by railroad officers from president down.

A very successful operating officer on another road follows the plan in hiring men for train crews and service of any similar character of taking as far as possible only those who give promise of capability of advancement. In a paper upon the subject of "Railroad Ethics" this officer said:

"We spend considerable sums for laboratories in which to test the materials which are to be used in construction and repairs; we know the history of every bit of wood, the wearing qualities of our paints and oils, the tensile strength of each piece of iron or steel; we keep careful watch of the working of every new device, noting its performance with the utmost anxiety; but what do we know of the men we employ? How do we satisfy ourselves of their fitness for the work, and, once in the service and charged with responsibility, what do we know of their habits and their tendencies? Employees are too often selected in a hap-hazard way by the head of the department who has need of their services at once with no reference to a higher purpose than present needs.

"More thought should be given to the capacity of the man to fulfil higher duties when called. However good a fireman you may think a man will make, if you are satisfied he has not the capacity to be a competent engineer don't employ him. A man may be strong and nimble enough to do duty as a brakeman, but if he has not the making of a good conductor in him, don't engage him."

The subject of the management of such matters is an important one and is not to be compassed by a few paragraphs, but if a suggestion of its bearing upon the success of a road is here offered the purpose in hand will be attained.

THE COST OF LOCOMOTIVE REPAIRS.

In locomotive departments the greatest expenditures are in three items—wages, fuel and repairs. It is unlikely that shop wages will furnish means for cutting down expenses, but in the use of fuel and the productiveness of men and machinery in the shops appear wide fields for improvement. Mechanical officers have many details to look after, and it is only recently that fuel economy has been given the high place in their thoughts which its importance deserves. It is now, however, a hobby well ridden by many men. Much has been accomplished in this direction during the past four years and perhaps more than in any similar period in the railroad history of the country. The locomotive is studied as it never was before and with shop tests as a basis most excellent improvements have been introduced and yet only a beginning has been made. An illustration of an important improvement is in connection with the recommendations of the committee of the Master Mechanics' Association last year with regard to exhaust nozzles and steam passages from trials of which encouraging reports were made at the recent convention. The importance of fuel economy and efficient operation of locomotives must not be lost sight of, and it will not be, but there is an almost equally important item in shop operation which should occupy attention.

One of the best papers which has appeared upon the subject of locomotive fuel was that by Mr. Wm. Forsyth, read in December, 1894, before the Western Railway Club. That paper has been in a way supplemented by one entitled: "The Cost of Locomotive Repairs and the Efficiency of Machine Tools in Railroad Shops," read by Mr. Forsyth before the same organization at its May meeting of this year. The cost of locomotive repairs was given a place alongside that of fuel cost, and the fact that this subject has been somewhat neglected is generally recognized by those who compare the methods of railroad shops with those of manufacturing concerns. The author of this paper gets at the root of the difficulty, and directs attention to the fact that mechanical officers do not know the cost of the details of their repair work. For this they are, perhaps, not to be blamed, but herein is a subject for reflection, investigation and education. The educational efforts should be directed toward bringing the higher officers of the railroads into a realization of

the importance of records from which the actual cost of work may be obtained, and into a correct way of using the results obtained. It may be said that every mechanical superintendent is fully aware of the saving which would be effected by replacing old, inadequate tools with new ones; but why, then, is it difficult for them to obtain appropriations for new and efficient ones? In answer to this Mr. Forsyth says: "It is the fault of the mechanical officers in not first ascertaining what is the cost of production under existing conditions and what would be the cost under improved conditions." Officers in charge of expenditures were never more ready to save money than they are now, and the explanation offered appears to be the correct one. If business administration of railroad properties is to be the rule, the cost of work must be known, and it must be had in terms which are adapted to the purpose of comparison in order to keep track of improvements.

The usual way of stating the cost of repairs is in terms of engine miles, and until recently this has also been true of statements of fuel records. This does not recognize in any way the amount of work done by the engines, and the results are really worthless for comparisons. Fair comparisons between different roads or upon different divisions of the same road cannot be made without taking many details into consideration, and the suggestion, made in the discussion of the paper referred to, to the effect that comparisons should be made only with previous records upon the same road or division is an excellent one. It is obviously unfair to compare the cost of repairs or of fuel upon the Lake Shore & Michigan Southern with that of the Union Pacific, but there is a tendency to make such comparisons.

The paper referred to is suggestive, and it merits wide attention, because it gets at the foundation of one of the most important matters now before the railroads and one which is intimately related to the management of men in the shops, but with this side of the question the author does not deal. He shows two ways in which the cost of repairs may be reduced. The first is by the introduction of new and efficient machinery, and the other by improvements over old methods. Among the improvements suggested are: Increased capacity of old tools, the use of more efficient new tools and more efficient work on the part of the men. He advocates systematic grinding of tools upon universal grinding machines, the use of the best of tool steel and other factors which tend to keep down the idle time of the machines The speeding up of belts to 4,000 or 4,500 feet per minute, the speeding up of machines, the use of heavy feeds and quicker return motions, all tend to produce the desired results. The author remarks that enterprising locomotive building concerns have discarded old machinery and installed the best up-to-date equipment in its place and expresses the opinion that the reason why railroads do not follow the same plan is that the repair accounts are buried in a large general operating expense and that they are assumed to be necessarily large and indefinite. To these suggestions might be added one to the effect that the underlying idea of this paper is also the basis for establishing piece-rate systems. The subject should be brought to the attention of managing officers and Mr. Forsyth's method of doing it seems admirable, that is, for the mechanical men to show what they can do with improved facilities.

MAINTENANCE RULE FOR INTERLOCKING IN ILLINOIS.

One of the most important factors in the safe handling of trains, whether fast ones or not, is the protection of crossings and junction points by interlocking apparatus. The safety of a fast train depends very largely upon the ability to stop in a short distance after the information is given that a stop is necessary, and signal appliances must be looked to to go give the information to the engine runners in season to enable them to make the stop at the proper place. Interlocking signals grow in importance with the increasing demands for fast service, and it is well that more careful attention should be given to this branch of engineering. This is specially true because of the necessity of keeping the apparatus in good condition at all times. Some roads have placed the care of signal apparatus in the hands of specialists. These are called "signal engineers," and very properly, when the men are fitted for their responsibilities, for the reason that the subject demands much study, engineering knowledge and experience for its mastery. These engineers are comparatively few in number and many roads intrust the care of signals to men who are not properly qualified for that important work. It may safely be said that those roads not having qualified engineers in charge of this apparatus are not treating their signaling problems properly. Accidents do not always immediately follow wrong design, faulty construction or careless maintenance of signals, but roads can hardly afford to ignore this matter, and it is appropriate to remind them that public sentiment may prove to be a hard master if they persist in its neglect. It is better that the roads should appreciate the importance of signaling and voluntarily take the necessary steps to put this department, along with that in charge of bridges, in a position to guarantee safety. Good bridges are necessary, and no carelessness or false economy is permitted in connection with them. Good signals well maintained are not less necessary, and yet the fact does not seem to be so generally appreciated.

The time is rapidly approaching when railroads will be driven to pay more attention to signals, and it is not altogether impossible that the rigidity of outside inspection will be applied here as it is in England. The roads will not relish this, but they have the remedy at hand, viz., to render such inspection unnecessary by the great care which they themselves give to the apparatus. The new clause which has just been added to the rules governing interlocking in Illinois is a step in the direction spoken of, and it has been found necessary in that State for the Railroad Commission to keep a closer watch of the maintenance of signals. The Railroad and Warehouse Commissioners of Illinois are practically responsible for the safety of interlocking apparatus, although until recently comparatively little attention has been paid to the manner of keeping the plants in repair. The new rule, however, renders it necessary for the railroads to file monthly reports of the condition of every plant with the commission, and blank forms are issued to the roads for this purpose. These reports are to cover the condition of the apparatus and of the crossing frogs, and they require statements of failures of the apparatus, the occurrence of derailments, with their causes, and the dates of inspection and names of inspectors are also to be given, all these to be signed by the officer in charge of the apparatus. In the event of a disagreement in the reports for each plant, and where such disagreement involves the safe operation of the appliances, it becomes the duty of the consulting engineer of the commission to investigate and report his findings to the board.

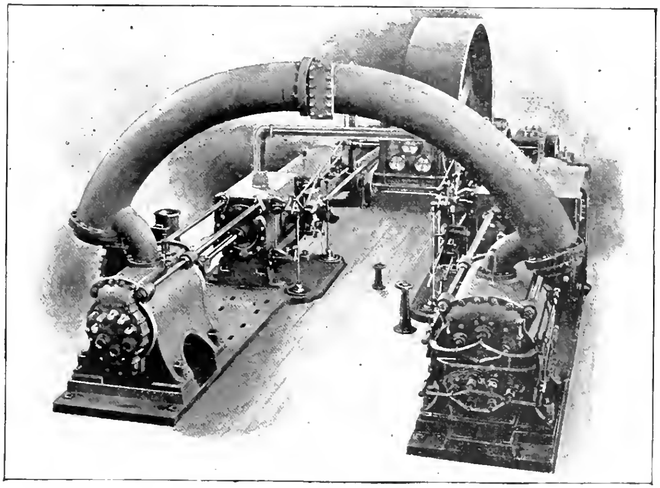
This is not the only State requiring such reports, Michigan having had a similar regulation in force for a number of years, and the tendency toward external supervision is apparently growing. That some rather sharp criticisms would be offered with regard to the Illinois rule was to be expected, but this only shows that the rule was necessary, because there can be no objection to reporting signal apparatus to be in good condition when it may be so reported and giving the authority for the statements. One decidedly good result is to be expected in the case of those companies desiring to properly maintain these devices who could not force other roads crossing them to give the necessary attention to maintenance. It appears to be necessary to force some railroads to protect themselves, and as long as this condition exists outside pressure should be brought to bear upon them. If it leads eventually to placing the supervision of signaling in the hands of the equivalent to the English "Board of Trade" the railroads have only themselves to blame, and there are very good reasons for believing that the roads will be much better off in respect to safety devices when this is accomplished. An excellent example of government supervision of safety appliances is seen in connection with the inspection of steam vessels. No one now finds fault with this system or thinks it undesirable, and the results of the inspection must be considered as most satisfactory. The equivalent of this should be had on the railroads with respect to signals, and if the roads themselves do not provide it others will.

A Rand Air Compressor—The Largest in Canada.

Under the title "A Large Rand Compressor" we published in our April issue of the current volume a brief description of the compressor recently furnished by The Rand Drill Company, of 100 Broadway, New York, to the Le Roi mine at Rossland, B. C. This is the largest compressor ever put into operation in Canada, and it was built at the Canadian works of the Rand Company at Sherbrooke, P. Q. It is described as a beautiful piece of mechanism by those who saw it standing on the shop floor when it was inspected prior to being shipped to the mine.

On the steam end the engine is of the Corliss type, made in the form of a cross-compound condensing machine. The high-pressure cylinder is 22 inches in diameter by 48 inches stroke, taking steam through a pipe 6 inches in diameter. The low-pressure cylinder on the opposite side of the machine is 40 inches in diameter by 48 inches stroke. Both cylinders are fitted with the Corliss liberating type valve, with vacuum dash pot, and with a sensitive governor operating on the release gear, to be operated automatically from six or eight revolutions to the maximum number of revolutions per minute. The main shaft is 14 inches in diameter by 13 feet long, weighing about 5,500 pounds. The shaft is fitted with cranks pressed on under immense pressure. The connecting rod forgings and piston rod forgings are well and carefully finished.

The air end of the machine is fitted tandem with the steam cylinders and is also compound, the high-pressure air cylinder being 22 inches in diameter by 48 inches stroke. The valve motion supplying these cylinders is Rand's most economical type, being in the form of mechanical valves. By this means the filling of the low-pressure cylinder with air at atmospheric pressure is insured, which fact largely affects the efficiency of the machine, for were the cylinder either not completely filled, or the air hot and expanded, the efficiency would be correspondingly decreased. The inlet valves of the low-pressure or intake air cylinder are surrounded by a hood which is connected to a flue for the introduction of the cold air from out of doors. Between the high and low-pressure cylinders is an intercooler of the latest type. Through this intercooler the air passes over a system of water circulating pipes and is cooled in the process. This compressor engine will be used for running all the pumps and hoists at the mine in addition to operating 40 drills.



A Large Air Compressor by The Rand Drill Company.

Books Received.

POWER-TRANSMISSION APPLIANCES. A catalogue of the Dodge Manufacturing Company, of Mishawaka, Ind,

ANNOUNCEMENT COLLEGE OF ENGINEERING AND THE MECHANIC ARTS OF THE UNIVERSISY OF MINNESOTA FOR 1897-1898.

PURDUE UNIVERSITY—ANNUAL CATALOGUE FOR 1896-1897. The annual catalogue of Purdue University, Lafayette, Indiana.

TENTH ANNUAL REPORT OF THE INTERSTATE COMMERCE COMMISSION. Dec. 1, 1896. Washington: Goverment Printing Office.

ANNUAL REPORT OF THE CITY ENGINEER, CITY OF PROVIDENCE, R. I., FOR THE YEAR 1896. From M. J. Herbert Shedd, City Engineer.

FORTY-SEVENTH ANNUAL REPORT OF THE BOARD OF DIRECTORS OF THE PANAMA RAILROAD COMPANY FOR THE YEAR ENDING DECEMBER 31, 1896.

FOURTEENTH ANNUAL REPORT OF THE BOARD OF RAILROAD COMMISSIONERS OF THE STATE OF NEW YORK FOR THE YEAR 1896. Two volumes, 1897. Maps.

SEVENTH ANNUAL REPORT OF THE BOARD OF DIRECTORS OF THE PITTSBURGH, CINCINNATI, CHICAGO & ST. LOUIS RAILWAY COMPANY, TOGETHER WITH ABSTRACTS FROM THE REPORTS OF THE COMPTROLLER AND THE GENERAL MANAGER, FOR THE YEAR ENDING DECEMBER 31, 1896.

THE SYNCHRONOGRAPH. A New Method of Rapidly Transmitting Intelligence by the Alternating Current, by Albert Cushing Crehore, Ph. D., Asst. Professor of Physics, Dartmouth College, and George Owen Squier, Ph. D., First Lieutenant of Artillery, United States Army, and Instructor of Electricity and Mines, U. S. Artillery School. Reprinted from the Proceedings of the American Institute of Electrical Engineers.

THE LOCOMOTIVE—ITS FAILURES AND REMEDIES. By Thomas Pearce. Published by D. Van Nortrand Company. 96 pages. (4½ by 7 inches in size.)

This little book was written by a locomotive runner on the Great Western Railway of England. Its object was to present the necessary information to candidates for the position of locomotive runners to enable them to pass the examinations which are now commonly held in that country. In an appendix plates are presented for the purpose of instructing in regard to the positions of the cranks, eccentrics and valves in order to make the required tests of the parts. The work is well adapted to the purpose of the writer, the language being direct, plain and easily understood. The subject has received intelligent treatment. It is arranged in the form of questions and answers.

Messrs. John Wiley & Sons announce that a book by Colonel H. S. Haines will soon be brought out by them. The title is "Addresses Delivered Before the American Railway Association." An appendix contains other addresses by Colonel Haines, who was President of the association referred to from 1890 to 1896.

Trade Catalogues.

[In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. These are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

CATALOGUE OF PRESSES, DROP HAMMERS AND DIES. Designed and built by The Stiles & Fladd Press Company, Watertown, N. Y. 1897. Standard size (6 by 9 inches), 64 pages, illustrated.

This catalogue is of special interest, because of the fact that it represents a single development of a single year, the first machine having been shipped May 1, 1896. It presents the design by this

company of power and foot presses, drop hammers, dies, power shears and special machinery, only those being shown which are considered as standards of the manufacturers. The variety of de_ sign is large, and the system followed in their construction admits of using such dimensions for stroke opening in the machine beds and similar features as may be required by the special demands the work to be done by purchasers. The pamphlet is well printed and illustrated.

THE WESTINGHOUSE HIGH-SPEED BRAKE. A DISTINCT ADVANCE IN THE AIR-BRAKE ART. The Westinghouse Air Brake Company, Pittsburgh, Pa., May 1, 1897; 16 pages, cloth, illustrated; not standard size.

The newly perfected "High-Speed Brake" is fully described and illustrated in this book, which will be read with interest by all who are concerned with the safety of high-speed train service. Space is not available at this time for an adequate notice of the improvement, but attention will be given it in a future issue.

THE FINEST TRAIN IN THE WORLD.

This is an eight-page pamphlet, handsomely illustrated, describing the Burlington trains between Chicago, St. Paul and Minneapolis, and the beauties of the scenery along the Mississippi River. It is from the press of Rogers & Wells, of Chicago, and is one of the most attractive pamphlets of the kind which we have received. It is printed in two colors and the engravings are very fine.

Personals.

De Volson Wood, Professor of Mechanical Engineering, Stevens Institute of Technology, died June 27, aged 65 years.

We are informed that after July 1 Mr. R. D. Wade, late Superintendent Motive Power of the Southern Railway, will act as Southern representative of the Baldwin Locomotive Works.

Mr Charles W. Dunn has been appointed Inspector of Material and Workmanship of the Brooks Locomotive Works at Dunkirk, N. Y. Mr. Dunn was formerly in the employ of Robert W. Hunt & Company, of Chicago.

It is reported that Mr. R. H. Soule has resigned the position of Superintendent of Motive Power of the Norfolk & Western and that Mr. W. H. Lewis, Master Mechanic of the Chicago, Burlington & Northern, succeeds him July 1.

Mr. John Ramsbottom, the predecessor of Mr. F. W. Webb, and one of the important figures in the railroad history of England, has just died in England. He was born in 1814, and was Locomotive Superintendent of the Manchester & Birmingham, and its successor, the London & North Western, for many years, beginning in 1842. He succeeded Mr. Francis Trevithick at the head of the Crewe works in 1857, and made the large extensions which converted those shops into a city. He was the designer of the Waverley class of locomotives, of which the "Lady of the Lake" was a well-known example. He invented the track tank for delivering water to locomotives in motion, and it was first used on the London & North Western. Mr. Ramsbottom retained the post of Consulting Engineer to the London & North Western down to the time of his death, and was President of the Institution of Mechanical Engineers.

Mr. Frank H. Soule, General Car Inspector of the N. Y., N. H. & H. R. R., died in New Haven, Conn., May 28, after a brief illness. Entering railroad service at the age of 17 years, he began in the shops of the old Boston, Hartford & Erie Railroad, at Readville, Mass, afterward controlled by the New England Railroad. He advanced rapidly and was soon made assistant to Mr. Marden, Superintendent of Car Department of the Fitchburg Railroad. Subsequently he became General Inspector of the Fast Freight Line between Boston and Chicago, where he served several years, after which he went to the Lake Shore & Michigan Southern Railroad as General Car Inspector, whence he came two and a half years ago to the New York, New Haven & Hartford Railroad in the same capacity. Mr. Soule was most favorably and widely known by railroad men throughout the country. His thorough knowledge, quick perception and absolute fairness in all that pertained to matters of car interchange won for him the respect and regard of his associates in the railroad world. He will be missed in the Master Car Builders' conventions, where his good judgment and wise counsel has done much toward bettering the conditions surrounding the inspection and interchange of car equipment, and his untimely death will be regretted by all who knew him.

National Electric Light Asssociation Convention.

The twentieth annual convention of the National Electric Light Association held at Niagara Falls, on the 8th, 9th and 10th of June, was considered by the delegates to be one of the most successful gatherings in the history of that organization. A number of very interesting papers were read and discussed. The attendance was unusually large and the exhibitions of electrical apparatus made by the different supply houses throughout the country was of more than ordinary completeness. The exhibit of the Westinghouse Electric and Manufacturing Company was especially attractive owing to its completeness and the many interesting features it contained. This company had on display several induction motors, direct current generators, alternating current generaters, switchboard apparatus, lightning arresters, converters, arc lamps and incandescent lamps, the latter forming an exhibit made by the Sawyer Man Electric Company, of Allegheny City, Pa.

Metallic Brake Beam Litigation.

We have received the following communication from the Chicago Railway Equipment Company concerning the status of reports of infringements of the National Hollow Brake Beam Company's patents. We desire to advise you that this company has instituted the following suits to determine its rights under its patents:

IN THE UNITED STATES CIRCUIT COURT AT ST. LOUIS, MO.

National Hollow Brake Beam Company and Chicago Railway Equipment Company, vs. Interchangeable Brake Beam Company. — In Equity No. 4047.

Chicago Railway Equipment Company, vs. Interchangeable Brake Beam Company. — In Equity No. 4048.

IN THE UNITED STATES CIRCUIT COURT AT SPRINGFIELD, ILL.

National Hollow Brake Beam Company and Chicago Railway Equipment Company, vs. Missouri Malleable Iron Company. — In Equity No. 8414.

Chicago Railway Equipment Company, vs. Missouri Malleable Iron Company. — In Equity No. 8415.

These suits—four in all—and in two different circuits, will, when finally decided, determine the question of infringement of the patents, and the liability of maker, seller and user of all brake beams of like construction to the one offered by us. We shall use every effort to bring the suits to a conclusion at as early date as possible.

CHICAGO RAILWAY EQUIPMENT COMPANY,
E. B. Leigh, General Manager.

EQUIPMENT AND MANUFACTURING NOTES.

The Pennsylvania Railroad is about to build five freight engines in its own shops.

The Richmond Locomotive Works will build 10 locomotives for the Southern Railway.

The Great Northern has ordered 15 19 by 26-inch moguls from the Brooks Locomotive Works.

The Baltimore & Ohio Railroad has ordered 15 locomotives of the Pittsburgh Locomotive Works.

The Jackson & Sharp Company has just finished 12 cars for the Norfolk, Virginia Beach & Southern.

The Allison Manufacturing Company has an order for 100 cars from the Westmoreland Coal Company.

The B. & O. Southwestern has ordered 200 freight cars of the Ohio Falls Car Manufacturing Company.

The Dickson Manufacturing Company is building a locomotive for the Buffalo & Susquehanna Railroad.

The Buffalo, Rochester & Pittsburgh has ordered 200 freight cars of the Buffalo Car Manufacturing Company.

The Baldwin Locomotive Works will build 18 16 by 24 inch American type locomotives for the Japanese government.

The Boston & Maine has ordered six passenger engines with 19 by 24-inch cylinders of the Manchester Locomotive Works.

The Mexico, Cuernavaca & Pacific has ordered 50 box and 2 caboose cars from the Missouri Car and Foundry Company, of St. Louis.

The Ashton safety valves, Nathan lubricators and Hancock inspirators will be used on the locomotives recently ordered by the Boston & Maine Railroad.

H K. Porter & Company, Pittsburgh, Pa., are reported to have recently received an order from the Russian government for light locomotives for use in Finland.

The Baldwin Locomotive Works will alter 15 simple locomotives for the Erie to the Vauclain compound system. This brings the nu nber so converted during the year to 13.

Efforts are being made by the Philadelphia & Reading Railroad Company to establish a direct steamship service between Philadelphia and the United Kingdom and the continent of Europe.

It is reported that the Gould Coupler Company, Buffalo, N. Y., will erect a plant at Brantford, Ont., to manufacture its devices for the Canadian trade. It may make use of the Grand Trunk shops, which are about to be vacated.

Announcement was made June 23 of the consolidation of the Pennsylvania Iron Works of Philadelphia with the Siemens-Halske Electrical Construction Company of Chicago. The result will be the strongest street railway equipment concern in the country.

The Ashton Pop Safety Valves have been selected for use on the new experimental locomotive which is under construction at the Schenectady Locomotive Works for Purdue University. These valves will control the high pressure of 250 pounds per square inch, the maximum to be used on the locomotive.

We are advised by Mr. William S. McGowan, Jr., Treasurer of the Hancock Inspirator Company, that that company has purchased the patents and the entire business of the Park Injector Company, of Boston and Whitman, Mass. All persons requiring information and prices of the Park injectors may obtain them from the Hancock Inspirator Company, of Boston, Mass.

Mr. W. B. Mack announces that the Mack Injector Company, of 35 Congress Street, Boston, is prepared to sell the "Torpedo" and other injectors, formerly manufactured by the National Tube Works Company. Mr. Mack was active at the recent conventions in the interest of this line of supplies, and exhibited drawings of the "Torpedo" injector in three classes, A, B and C.

The Ashton Valve Company, of 271 Franklin Street, Boston, has continued to do a good business through the financial depression. Among the locomotives now being built upon which the Ashton pop valves are to be used are a number for the following roads: The Boston & Maine, the Rio Grande Western and the Houston & Texas Central.

The Peerless Rubber Manufacturing Company has just issued a new circular describing its chief specialties, such as "Rainbow," "Honest John," "Hercules" and "Peerless" packings. This will interest readers who desire information pertaining to packing. The best "compliment" paid to a manufacturer is to imitate his product, and this has been done with the "Rainbow" packing, which is unquestionably the best packing available for the purposes to which it is adapted.

Among the other orders recently received by the Schenectady Locomotive Works is one for eight 10-wheel compound freight locomotives, having cylinders 22 and 34 by 26 inches, for the Northern Pacific Railroad. (These engines are duplicate of two of the same class built for the Northern Pacific, by the Schenectady Works, last March;) five 10-wheel freight engines, cylinders 18 by 24 inches, for the Florida East Coast Line; two 8-wheel passenger engines, cylinders 18 by 24 inches, for the Detroit, Grand Rapids & Western, and two 6-wheel switching locomotives, cylinders, 19 by 24 inches for the Houston & Texas Central.

The Schnectady Locomotive Works has received an order for 12 narrow-gage passenger locomotives for the Kiushiu Railway Company of Japan. The general design is of the American type, with cylinders 16 inches diameter and 24 inches stroke, and the driving wheels are 56 inches diameter. The tenders have six wheels, the general design being similar to that used on the railroads of England. The locomotives are to be built to run on 3-feet 6-inch track, that being the standard gage of the railroads of Japan. On completion, each locomotive will be tested under steam on a temporary track at the works, and after inspection will be taken apart and packed for loading on steamship at New York.

Among the exhibits at the conventions was one of the Vim special air-brake hose by the Boston Woven Hose and Rubber Company, of 275 Devonshire street, Boston, Mass. This hose consists of a heavy rubber inner tube surrounded by a seamless woven tube of cotton, which is again surrounded by a rubber tube and over this is another of seamless cotton. The whole is then enveloped in an outside rubber tube. The product is a strong pliable hose with the elements in close contact, the object of the construction being to insure strength together with the necessary provisions against kinking. The same plan is followed in making steam hose, but the inner tube is then made of rubber which is specially selected for resisting the effects of the steam. This type of hose is claimed to be the equivalent in strength to what is ordinarily termed four-ply hose.

Our Directory

OF OFFICIAL CHANGES IN JUNE.

Canadian Pacific.—Mr. W. Cross has been appointed Master Mechanic of all Canadian Pacific lines west of Fort Williams, with headquarters at Winnipeg.

Columbus, Sandusky & Hocking.—Mr. Samuel M. Felton, President and Receiver of the Cincinnati, New Orleans & Texas Pacific, was, on June 2, appointed Receiver of the Columbus, Sandusky & Hocking.

Fort Wayne, Terra Haute & Southwestern.—Mr. Frank P. Welsh has resigned as Receiver, and has been succeeded by Mr. Frank L. Winsor, with headquarters at Rock Island, Ill.

Fort Wayne & Rio Grande.—Mr. H. D. Galbraith has resigned as Master Mechanic, and Mr. B. G. Plummer has been appointed Master Mechanic, with headquarters at Fort Worth, Tex.

Grand Trunk.—Mr. J. A. Slack has resigned the position of Assistant Master Mechanic at Butte Creek, Mich., and the office has been abolished.

Harriman & Northeastern.—Mr. George W. Chandler, General Manager, was on May 20 appointed Receiver of that road.

International & Great Northern.—Mr. E. C. Manson, Superintendent Car Service, and Mr. W. E. Williams, Purchasing Agent, have retired, and their duties will be performed by General Superintendent Noble, at Palestine, Tex. Mr. T. M. Campbell has resigned as General Manager. He has held the position since 1892. Mr. Leroy Trice has been appointed General Superintendent. Geo. L. Noble was on May 25, 1897, appointed Assistant General Superintendent, vice E. O. Griffin, previously General Manager's Assistant.

Lehigh Valley.—Mr. J. Campbell, Master Mechanic at Buffalo, has had his jurisdiction extended over the car department at that point.

Louisville & Nashville.—Mr. Charles E. Slade, formerly Master Mechanic of the Louisville & Nashville, died at New Orleans, La., a few days ago.

Mexican Southeastern.—Mr. W. A. M. Lennan, of Montreal, has been appointed General Purchasing Agent, with headquarters in Cleveland, O.

Minneapolis & St. Louis.—Mr. L. L. Day, formerly Chairman of the Southwestern Traffic Association, has been appointed General Manager, with headquarters at Minneapolis, Minn.

Monterey & Mexican Gulf.—Mr. A. Mounom, General Manager, has resigned, and will be succeeded by Mr. J. H. Mathey, of Brussels, Belgium.

New Jersey & New York Railroad.—Mr. Geo. M. Cumming has been elected first Vice President of this company, with office at No. 21 Cortlandt Street, New York.

Pittsburgh, Bessemer & Lake Erie.—Mr. J. L. Blim has resigned as General Manager and was appointed General Agent of that company.

Plant System.—Mr. Frank I. Brown, of Boston, has been elected Third Vice-President, in place of Mr. D. F. Jack, resigned. Mr. Brown is also President of the Florida Southern Railway.

San Diego, Cuyamaca & Eastern Railway.—Mr. Heber Ingle has been elected President, and Mr. Levi Chase Vice-President of this company.

Sedalia, Marshall & Miami.—Mr. J. E. House, of Omaha, has been appointed Chief Engineer of this proposed line, and is now preparing for the survey.

South Carolina & Georgia.—Mr. Joseph H. Lunds, formerly General Manager of the Norfolk & Western, has been appointed General Manager of this road, with headquarters at Charleston, S. C. He takes the place of Mr. E. S. Bowen, who is reported to have resigned on account of ill health.

South Shore Railway.—F. X. Choquet has been elected President, with office at Montreal, Que.

Wabash.—Mr. Richard Purcell, formerly Division Superintendent and Master Mechanic of the Wabash, died at Quincy, Ill., May 21, aged 80 years.

Williamsport & North Branch.—The resignation of Mr. H. C. McCormick as President of the Williamsport & North Branch was accepted at the annual meeting June 4. The other officers were re-elected.

Exhibits at the Conventions.

The following is a complete list of the exhibits at the Master Car Builders and Master Mechanics' Conventions:

Acme Machinery Company, Cleveland, O.; double bolt cutter, with Fergusson's air-operated turrets. Represented by A. H. Carpenter.

Adams & Westlake Company, Chicago; car fixtures.

Ajax Metal Company, Philadelphia, Pa.

American Brake Beam Company, Chicago.

American Steel Casting Company, Thurlow, Pa.

American Steel Foundry Company, St. Louis.

Ashton Valve Company, Boston, Mass.

Automatic Air and Steam Coupler Company, St. Louis, air and steam coupler in operation.

Automatic Lubricator Company, Rochester, N. Y.

Bettendorf Axle Company, Davenport, Ia.; Bettendorf brake beam complete and parts for assembling.

B. E. Tilden Company, Chicago.

Boston Belting Company, Boston; full line of mechanical rubber supplies.

Boston Woven Hose and Rubber Company, Boston; air brake and steam hose and railroad rubber goods. Represented by J. O. De Wulf and A. L. Whipple.

Bosley, The D. W. Company, Chicago.

Brown & Sharp, Providence, R. I.

Buckeye Malleable Iron and Coupler Company, Columbus, O.

Brill, J. G. Company, Philadelphia; model of Brill truck.

Baker Forge Company, Ellwood City, Pa.; brake rod and other forgings.

Bushnell Manufacturing Company, Easton, Pa.

Chicago Grain Door Company, Chicago, Ill.

Chicago Pneumatic Tool Company, Chicago; pneumatic piston drills, Boyer pneumatic hammers, flue welder, speed recorder in operation, pneumatic riveter, Manning sand papering machine.

Chicago Railway Equipment Company, Chicago; National hollow brake beam and automatic frictionless side-bearing.

Cloud Steel Truck Company, Chicago; freight car showing the Cloud tender truck with elliptic springs, and freight truck with coil springs, also truck frame and Bettendorf I beam truck and body bolsters.

Composite Brake Shoe Company, Boston; composite brakeshoe with cork inserts.

Cook Cooler Company, Flint, Mich.; the Cook journal cooler.

Crosby Steam Gage Company, Boston.

Curtis & Company Manufacturing Company, St. Louis; 8 × 8 steam driven air compressor, in operation, 6×6 belt-driven air compressors.

Detroit Lubricator Company, Detroit, Mich., improved triple locomotive lubricator.

Detrick & Harvey Machine Company, Baltimore, Md.

Dressel Railway Lamp Works, New York; lamps.

Edgar Sebring Car Seal and Lock Company, Colorado Springs, Col.

Erie Malleable Iron Company, Erie, Pa.; the Erie coupler.

Fairbanks, Morse & Company, Chicago; three horse-power combined gasoline pumping engine in operation, Barrett car jack, Sheffield hand car wheel, model of Sheffield hand car.

Franklin Steel Castings Company, Franklin, Pa.; the Lone Star coupler.

F. W. Bird & Son, East Walope, Mass.; torsion proof car roof and Neponset insulating paper.

Gould Coupler Company, New York; the new Gould freight coupler, friction uncoupling device, spring freight car buffers, Gould passenger coupler for express cars without platforms.

Goodwin Car Company, Chicago; full sized dumping car on the grounds and model in exhibition room.

Gravity Car Coupling Company, Colorado Springs, Colo.; models of Gravity coupler.

Gold Car Heating Company, New York and Chicago; steam heating system, full size, under steam, and full line of electric heaters.

Hancock Inspirator Company, Boston; the Hancock inspirator, boiler checks, ejector and hose strainer.

Hale & Kilburn Manufacturing Company, Philadelphia, Pa.; new "Walkover" seat with movable foot rest and oval pedestal base, and "Reversible" car seat with new base and foot rest.

Hinson Manufacturing Company, Chicago; refacing pin.

H. W. Johns Manufacturing Company, New York; asbestos, vulcabeston, boiler and pipe coverings, packing, etc.

H. H. Hewett, Buffalo; model of the Hewett rolled steel truck.

Interchangeable Brake Beam Company, St. Louis; the interchangeable brake beam.

Jenkins Bros., New York; the Jenkins valves.

Joyce, Cridland & Company, Dayton; geared lever jack.

John R. Jones, Philadelphia; model of steel car wheel rolling machine.

Keasbey Matteson Company, Ambler, Pa.; magnesia covering for boilers and pipes.

Kinzer & Jones Manufacturing Company, Pittsburg, Pa.; Kinzer brake shoe.

Knitted Mattress Company, Canton Junction, Mass.

Leach Locomotive Sander, Boston; locomotive sander.

McCord & Company, Chicago; the McCord journal box and lid.

Main Belting Company, Philadelphia; Leviathan belting in various sizes from 90 inches in width down.

Marion Car Coupler Company, Marion, O.; the Murphy automatic car coupler.

Marion Car Coupler Company, Marion, O.; the Murphy automatic car coupler.

Mason Regulator Company, Boston; locomotive reducing valves pump governors, boiler feed pumps, airbrake regulators and damper regulators.

Michigan Malleable Iron Company, Detroit; the Detroit coupler, Thornburgh coupler attachment.

Missouri Malleable Iron Company, St. Louis; refined malleable castings for railways.

Monarch Brake Beam Company, Detroit; Monarch brakebeams.

Moran Flexible Steam Joint Company, Louisville, Ky., joints under steam and air pressure, all sizes.

McConley & Torley Company, Pittsburgh, Pa.; Janney Coupler and new locking attachment.

Mr. Hyde, Philadelphia; improved journal box.

National Car Coupler Company, Chicago; national buffer, national miller combination, national freight car coupler.

National Malleable Castings Company, Cleveland; Tower coupler, oil boxes, bolsters, journal box lids, carlin pockets, uncoupling hose attachments, door fastenings and other specialties.

National Railway Specialty Company, Chicago; security door.

New York Belting & Packing Co., New York; steam and air brake hose and interlocking rubber tiling.

New York Rail Insulation & Equipment Company, Newark, N. J.

Norton, A. O., Boston; Norton's improved ball-bearing ratchet screw jacks.

Niles Tool Works Company, Hamilton, O.

P. H. Murphy Manufacturing Company, St. Louis; Murphy improved Winslow car roof.

Pantasote Leather Company, New York; car curtains, car seats and car headlinings.

Pearson Jack Company, New York; car replacing jack.

Peerless Car Coupler Company, New York; Peerless couplers.

Peerless Rubber Manufacturing Company, New York; full line of mechanical goods, including the famous Rainbaw packing.

Pencoyd Iron Works, Pencoyd, Pa.; car and engine axles.

Pratt & Letchworth, Buffalo; malleable iron car castings, steel castings for locomotives and cars, automatic freight car coupler.

The Pyle National Electric Headlight Company, Chicago.

Q & C Company, Chicago; McKee brake slack adjuster and Hoyt flush door.

Rand Drill Company, New York and Chicago; duplex belt driven air compressor furnishing air for Chicago Pneumatic Tool Company.

Railroad Supply Company, Chicago; Hein double automatic car coupler, Universal release rig journal box lifter.

Revere Rubber Company, of Boston; full line of railway rubber goods.

Richmond Locomotive and Machine Works.

Safety Car Heating and Lighting Company, New York City.

Safety Car Coupling, Philadelphia.

Sams Automatic Car Coupler Company, Denver, Col.; the Sams coupler.

Schoen Pressed Steel Company, Pittsburgh, Pa.; steel cars and trucks.

Shelby Steel Tube Company, Shelby, O.; boiler flues.

Silvius & Company, E. T., Indianapolis Ind.; improved journal box for engine trucks.

Sherry Torch Company, Rochester, N. Y.

Simplex Railway Appliance Company, Chicago; Simplex steel and malleable iron bolster.

Standard Paint Company, New York; sample of Ruberoid roofing.

Sterlingworth Railway Supply Company, New York; brake beams.

Shickle, Harrison & Howard Iron Company, St. Louis, one diamond-shaped truck, with steel frame and bolster.

S. T. Cummings, Del Rio, Tex.; locomotive ash pan.

Standard Coupler Company; standard steel passenger platform butling mechanism and coupler.

The Babcock Tire-Trimming Company, Johnsonburg, Pa.; the Babcock tire trimmer.

The Railroad Signal Lamp and Lantern Company, New York.

The Sinclair-Scott Company, Baltimore, Md.; the Royal Flush car door.

The Smillie Coupler Company, Newark, N. J.; the Smillie coupler

Star Brass Company, Boston; locomotive pop valves, steam gauges and locomotive appliances.

Toledo Railway Appliance Company; gravity air brake dust guard.

Watson & Stillman, New York; crank pin press, girder rail bender, rail punches, piston-rod jack, hydraulic jacks.

Webster Manufacturing Company, Chicago; gas engine operating Rand drill for Chicago Pneumatic Tool Company.

Western Railway Equipment Company, St. Louis; Houston pneumatic sander, St. Louis single track flush car door, economy slack adjuster, combination lug and follower casting, Missouri draft attachment, safety truck end casting.

Wilmington Malleable Iron Company, Wilmington, Del.

Yerdon William, Fort Plain, N. Y.; improved double hose-band.

Complements of the Conventions.

The surroundings of Fortress Monroe are most admirably adapted to render the place an interesting one for the conventions. The scientific work which is going on at the fort is itself worth a trip to investigate, as this is one of the most important of the artillery stations of the United States Army and a great deal of interesting investigation is conducted there with reference to projectiles and their flights. Through the efforts of the officers of the Richmond Locomotive Works the members of the associations and their friends were enabled to inspect the battleship *Texas* which was ordered to Old Point Comfort for the purpose. This ship was particularly interesting because the machinery was built by the concern mentioned.

The other attractions of the neighborhood were the Newport News shipyards and the Norfolk Navy Yard, to both of which the members were invited. The Richmond Locomotive Works were visited by the members and guests in a body, by courtesy of the officers of the works and the Chesapeake & Ohio Railroad, and the trip was a profitable one. It would probably be impossible to select a place for the conventions where more opportunities would be offered for profitable visits to manufacturing plants unless the conventions were held in a large city. Among the pleasant excursions were two by water, one being provided by Mr. W. S. Morris, of the Chesapeake & Ohio Railroad, and the other by Mr. E. St. John, Vice-President and General Manager, and Mr. W. T. Reed, Superintendent of Motive Power of the Seaboard Air Line. The latter trip gave an opportunity for a number of railroad men to inspect the terminal facilities of the Seaboard Air Line in Norfolk and Portsmouth. The terminal tug *Dorothea* was tendered for the occasion, in charge of Capt. George W. Mansfield, and the excellent appointments of the boat and the neatness of everything on board occasioned many favorable comments and contributed to the enjoyment of the party. The exhibits this year were instructive, and among the most noteworthy were the metallic cars, considerable advance having been made during the year in this field. The Schoen pressed steel cars built by the Schoen Pressed Steel Co., constituted one of the most interesting of the exhibits.

MASTER CAR BUILDERS' ASSOCIATION.

ABSTRACTS AND SUMMARIES OF REPORTS PRESENTED AT THE THIRTY-FIRST ANNUAL CONVENTION.

Specifications and Guarantee for Cast-Iron Wheels.

J. N. Barr, S. P. Bush, John Hodge, J. H. McConnell, Wm. McWood, committee.

No radical change in the specifications is recommended.

Section 1 is made somewhat more definite and the variation allowed in the diameter of the same chill is reduced from $\frac{1}{16}$ to $\frac{1}{32}$ of an inch.

Sec. 2 is modified by the addition of the words "swollen rims."

Sec. 3 is modified by increasing the maximum allowable depth of white iron on the tread from ⅞ to 1 inch and increasing the minimum in the throat from $\frac{3}{16}$ to $\frac{1}{4}$ inch. It is believed that these changes are desirable and can be readily complied with.

Sec. 4 is changed by adding the thermal test, which consists in heating the tread of the wheel with molten metal. It is universally conceded that in almost all cases of wheels broken in pieces the cause is rapid heating of the rim from application of the brakes, and the proposed test reproduces such circumstances more perfectly than any other tests which have been suggested. The only question with reference to this test is whether the test as proposed is not so severe that in order to meet it the wheel-makers may be compelled to use materials which will seriously impair the durability of the wheel. The testimony on the subject, however, is of such a character as to induce your committee to recommend this test. [See closing paragraph of this report for this test.]

Sec. 5 and Sec. 6 have not been changed.

Sec. 7 has been altered so as to call for the use of the M. C. B. limit gage for flanges.

Sec. 8 is practically unchanged, except that the name of the maker and place of manufacture is called for.

Sec. 9 is a new section and is simply called for to complete the proper applications of the specification.

Your committee is of the opinion that the guarantee adopted in 1893 has never been put in practical operation, and is inclined to think that in some of its requirements it is impractical. After securing proper strength, which is effected by the general specifications, the most important consideration to a railroad company is that of mileage. Our specifications are quite full on the matter of strength, but strength to a great extent varies inversely as durability. Setting aside cases of breakage arising from allowing wheels to run until the flange is worn too thin or the tread too much worn, the breakage of wheels seems to be caused almost exclusively by rapid expansion of the rim due to severe application of the brakes. From this point of view the strength of the wheel is increased:

1. By the use of soft tough iron;
2. By doctoring mixture with ferro-manganese;
3. By reducing the amount of scrap;
4. By softening the mixture and thus reducing the depth of white or chilled iron on the tread;
5. By methods of manufacture.

The durability of the wheel is increased:

1. By the use of hard, brittle irons.
2. By avoiding the use of ferro-manganese.
3. By reducing the amount of scrap;
4. By hardening the mixture and thus increasing the depth of white or chilled iron in the tread;
5. By methods of manufreture.

It will be seen by the above that items 1, 2 and 4, which tend to increase the strength of the wheel, are diametrically opposite to items 1, 2 and 4, which go to increase the durability of the wheel. It is a difficult matter for railroad officials to go into the minute details of wheel manufacture. A test for strength is of service, but is not sufficient to determine the actual value of wheels when that value depends so much upon the durability of the wheel as well as its strength.

An ideal specification for wheels would be as follows:

1. The chill test must show the mixture chilling ⅞ inch deep.
2. The chill on the tread of the wheel must be within $\frac{1}{16}$ inch as deep as on the chill test, and must be uniform in depth around the tread.
3. The chill in the throat must be within $\frac{1}{16}$ inch as deep as on the tread.
4. Wheels of the same nominal diameter must not vary more than $\frac{1}{8}$ inch above or below the mean size measured on the circumference.
5. Wheels must be perfectly cylindrical.
6. The tread of the wheel must be perfectly smooth and free from wrinkles, sweat or defects of any kind.
7. The body of the wheel must be free from any defects incident to general foundry work.
8. Wheels must stand a strength test as specified.

A glance at our present specifications shows how far short of these conditions the average wheel falls. It can be stated as a fact that the mileage of the best average wheels is nearly twice as great as the average of the poorer wheels. This is most important for railroad officials to consider. They are not in position to watch the details of manufacture or the materials used, or to determine by an inspection of a few wheels how much wheel service they loose by wheels falting short of the best that can be done in material, strength, chill, etc. If now railroad officials should purchase mileage instead of wheels they would get just what they pay for, and if one wheel-maker should furnish 200,000 miles of wheel mileage for less money than another, there would be no uncertainty in the contract, as there is when wheels are bought for, say, $5, when $6 wheels may furnish $10 worth of mileage as compared with the $5 wheels.

TEST OF C., M. & ST. P. RY. CO. WHEELS MADE UNDER THE 100 POUND WEIGHT, DROPPING 7 FEET CLOSE TO RIM.

"Heavy Pattern."

No. of Wheel.	Date cast.	Chill Test.	Chill. Tread.	Chill. Throat.	No. of blows.	Defects.	Weight of wheel.
							Lbs.
97,060	1, 7, 96	16	12-8	11-10	63	Breakdown	580
98,469	1, 25, 96	16	12-11	10-9	64	Sand wash.	"
98,642	1, 29, 96	16	11-10	9 8	160	Swelled flange.	"
99,769	2, 15, 96	17	12 12	10-9	153	Breakdown.	"
265	2, 25, 96	16	8-7	6-5	152	"	"
713	3, 4, 96	16	10-9	8-7	102	Swelled flange.	"
4,810	5, 14, 96	16	10-9	8 7	84	Breakdown.	"
4,914	5, 18, 96	16	14-12	10-10	99	"	"
5,643	5, 28, 96	16	11-10	9-8	44	"	"
5,972	6, 1, 96	16	10-9	8-7	67	"	"
7,200	6, 25, 96	16	13-12	11 10	56	"	"
7,480	6, 30, 96	16	8-7	6-5	35	Light plate.	"
9,549	8, 6, 96	16	10-9	8 7	64	Breakdown.	"
10,414	8, 22, 96	16	10-9	8-7	84	Swelled rim.	"
10,900	8, 31, 96	16	10 9	8-7	42	Breakdown.	"
15,563	11, 16, 96	16	10-9	8-7	200	"	"
Average blows					91½		

TEST OF C., M. & ST. P. RY. CO WHEELS MADE UNDER THE 100 POUND WEIGHT, DROPPING 7 FEET CLOSE TO RIM OF WHEEL.

"Light Pattern."

No. of wheel.	Date cast.	Chill test.	Chill. Tread.	Chill. Throat.	No. of blows.	Defects.	Weight of wheel.
3,400	4, 20, 96	16	5 8	6 5	91	Light plate	551
3,676	4, 23, 96	16	12-10	9-8	36	" "	"
7,830	7, 7, 96	16	12-11	10-9	22	Breakdown	"
9,134	7, 29, 96	15	12-10	9-8	78	"	"
10,408	8, 22, 96	16	12-11	10-9	46	Swelled rim	"
12,695	10, 1, 96	16	12-11	11-10	65	Breakdown	"
15,690	11, 18, 96	16	13-12	10 10	47	Light flange	"
16,327	11, 30, 96	16	10-9	8-7	85	Breakdown	"
Average blows..........................					58¾		

The average service of a fair ordinary chilled wheel is between seven and eight years, and in many cases this average is increased to twelve or fourteen years. The futility of a four or five year guarantee can be readily seen from the above

In the matter of weight of wheels, your committee has received various recommendations showing a wide range of opinion as to what is the proper weight. For instance, for 60,000 pound cars the recommendations run from 540 pounds to 700 pounds. It is the opinion of your committee that with fair material a 580-pound wheel is perfectly safe for 60,000-pound cars, and in view of the fact that the lighter cars are rapidly disappearing, it is recommended that wheels less than 550 pounds should not be cast.

The tables attached show the number of blows required to break a piece out of the wheel, the drop weighing 100 pounds and falling 7 feet, the test having been made on one lot of wheels denominated "light pattern," which weighed 550 pounds, the other test being made on a lot of wheels denominated "heavy pattern," which weighed 580 pounds. It will be seen that the average number of blows necessary to break a piece out of the light, or 550-pound pattern, was 58; with the 580-pound pattern the number of blows required to break a piece out was 91. This shows a very great increase in strength produced by the addition of an average of 26 pounds to the weight of the wheel as revealed by the drop test, and it would seem to indicate that if the 550-pound wheels gave satisfactory service under 40,000-pound cars and lighter, that the increase in strength in 580-pound wheels more than meets the increased requirements of service under 60,000-pound cars. Your committee is not able to give any comparisons at present so far as the thermal test is concerned.

The question of the shape of wheel is so indefinite that your committee hesitates to make any special recommendations in the matter of the shape of wheel.

[The thermal test above referred to is as follows: The wheel must be laid flange down in the sand, and a channel way 1½ inches wide and 4 inches deep, must be molded with green sand around the wheel. The clean tread of the wheel must form one side of this channel way, and the clean flange must form as much of the bottom as its width will cover. The channel way must then be filled to the top with molten cast iron, which must be hot enough when poured, so that the ring which is formed, when the metal is cold, shall be solid or free from wrinkles or layers. The time when the pouring ceases must be noted, and two minutes later an examination of the wheel must be made. If the wheel is found broken in pieces, or if any crack in the plate extends through the tread in either of the wheels tested, the 100 wheels represented by the tests will be rejected.]

Arch Bars and Column Bolts for Diamond Trucks.

E. D. Nelson, George Gibbs, J. E. Simons, T. Lyon and J. H. Rankin, committee.

The principal variables which affect the cross-section of the arch-bars are:

1. The wheel-base of the truck.
2. The vertical distance between arch bars in the center portion of the side frame of the truck.
3. The location of the point of junction of the top and bottom arch bars vertically; that is, making the set equal, or making the bottom arch bar with more set, and the top arch bar with less set, or the reverse.
4. The distance between centers of the column bolts.

These variables make it desirable to group the trucks within certain limits, because it is necessary to have different sections of arch bars in different designs of trucks, depending on the variables mentioned.

Taking the results obtained by means of the analysis referred to, your committee would recommend for cars of 60,000 pounds capacity the dimensions of arch bars and column bolts as shown in the following table:

Wheel base.	Distance between top and bottom arch bars at column bolts.	Cross-section of bars. Top arch bar.	Bottom arch bar.	Tie bar.	Diam. of column bolt.
	Inches.	Inches.	Inches.	Inches.	Inches.
Greater than 5 feet and not more than 5 feet 6 inches...	11½ to 16½	1⅜ by 4	1¼ by 4	½ by 4	1⅜
	16½ and greater	1¼ by 4	1⅛ by 4	½ by 4	1⅜
5 feet...............	14½ to 16½	1¼ by 4	1⅛ by 4	½ by 4	1⅜
	16½ and greater	1⅛ by 4	1 by 4	½ by 4	1⅜
Less than 5 feet...	14½ to 16½	1⅛ by 4	1 by 4	½ by 4	1⅜
	16½ and greater	1 by 4	⅞ by 4	½ by 4	1⅜

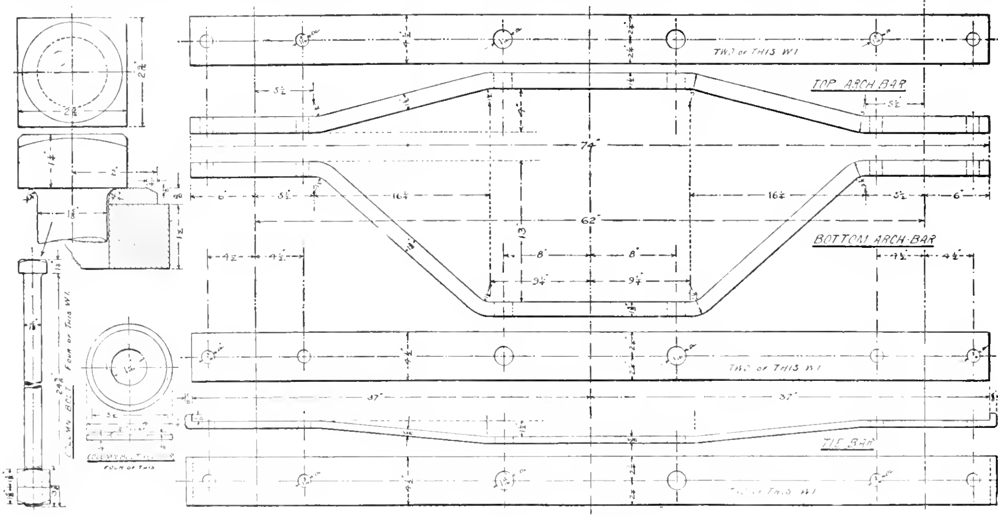
The diameter of the column bolt shown is that when four are used per truck, two through each arch bar. The diameter of 1⅜ inches may seem somewhat large, but it was thought better than using a smaller diameter in order to provide for wear in certain classes of truck.

In recommending these sizes, it is assumed that material of good quality is used. Wrought iron or steel having a tensile strength of 50,000 to 55,000 pounds per square inch, and an elongation of 20 per cent. on a section originally two inches long, would satisfactorily fill the requirements. Material having a tensile strength of less than 48,000 or more than 60,000 pounds per square inch, or showing less than 15 per cent. elongaton on a section originally two inches long, or if the test piece shows a granular fracture covering more than 50 per cent. of the fractured surface, should not be used. The material should also be free from cracks or fractures when bent to the required forms.

Your committee does not find it possible, as it hoped might be done, to recommend any standard design, showing amount of set, etc., for arch bars in trucks of 60,000-pound cars.

For a truck to carry cars of 80,000 pounds capacity, your committee would recommend for the top arch bars a section 1½ by 4½ inches, and for bottom arch bars 1⅜ by 4½ inches; tie bars ⅝ by 4½ inches.

The arch bars and design of same are shown in accompanying drawing. The box for which the bars are designed is the same as that adopted for recommended practice by the association on recommendation of a committee reporting to the convention of 1896.



Arch Bars for Diamond Trucks, 80,000 Pounds Capacity.

Automatic Couplers.

C. M. Mendenhall, A. E. Mitchell, W. Garstang, W. H. Thomas, T. G. Duncan, J. M. Macbeth and J. T. Chamberlain, committee.

After mentioning the deviations which had been made from the standard design the following recommendations were made:

(1) That the design of the M. C. B. coupler shank, adopted as standard in 1893, be continued without change as the standard of the association.

It is considered impracticable to drill the rivet holes through

coupler shanks; and on account of the variations due to cored holes we think the lips on the ends of straps should remain, but to insure an easy bend there should be added a dimension showing radius of ¼ inch on inside at back corners. The committee would therefore recommend:

(2) That the design of pocket strap included in the recommended practices of the association and shown in Sheet B of Proceedings for 1896, with a radius of ¼ inch at inside back corners, be made a standard of the association.

Trains Parting.

A. M. WAITT, W. LAVERY, F. H. SOULE, D. HAWKSWORTH and B. E. THOMPSON, committee.

During the discussion at the 1896 convention, it was shown that the railways were menaced by a continuation of "break-in-two" evils which we had confidently expected would be overcome by the introduction of the M. C. B. type of coupler. Figures were given at that time indicating that it was possible that this evil was being increased rather than diminished by the supposed improvement. Such a state of things would be truly alarming, and it is with pleasure that your committee can report that the M. C. B. coupler itself can be charged with the responsibility for increasing the danger of train operation.

Much has been said and written in the last few years about foundation brake rigging, and the need of greater care in its design and application. There is perhaps an equal, if not greater, need for study in the improvement in design and application of draft rigging and of the M. C. B. couplers on our freight equipment. The data obtained from replies to our circular of inquiry, together with an extended observation at home and abroad on our railways, have convinced your committee that some radical steps must be taken to improve and maintain in proper shape the couplers, draft rigging and attachments to same on our cars.

A summary of the facts obtained from the 31 railway companies, representing 37,490 miles of track and 376,010 cars, shows in an average period of 105 days the alarmingly large total of 5,775 cases of trains parting, 103 of which were accompanied by serious damage, and in some cases loss of life. This shows an average of 55 cases of trains parting per day, and this on only a very small percentage of the railway mileage of the United States. Of the above cases, fortunately most of them occurred at speeds of under 20 miles per hour, and many of them occurred just as the trains were pulling out after having slacked up. On one road where an exceedingly rigid investigation of every case of train parting has for some time been made, it was found that only $\frac{75}{100}$ of one per cent. of the cases occurred in connection with the application of air-brakes, and this experience seems to be substantiated by nearly all the reports.

The following table, tabulated from the replies to our circular of inquiry, will give a good idea of the comparative frequency of trains parting from different causes:

Total number of cases in 105 days	5,775		
Average number of cases per day for 31 roads	55		
Number of cases due to—			
Broken links and pins	1,517	26 27	per cent.
Link and pin drawbars in addition to above	1,081	18.72	"
Total due to use of link and pin drawbars	2,598	44.99	"
Broken coupler spindles	708	12.26	"
Broken coupler pockets	86	1.49	"
Defective draft rigging	228	3.94	"
Failure or defects in M. C. B. couplers or their attachments	2,155	37.32	"
Total	5,775		

In connection with the M. C. B. couplers and attachments which caused cases of trains parting, the details are as follows:

Number of cases due to—			
Worn knuckles	195	9.05	per cent.
Broken or defective locks	886	41.11	"
Excessive amount of slack in draft rigging	672	31.13	"
Improper adjustment of uncoupling attachments.	234	10.86	"
Other miscellaneous causes	168	7.79	"
Total	2,155		

The foregoing figures give much food for reflection and action.

First.—It is seen that we are fully justified in considering links and pins a very weak and unsatisfactory feature in connection with coupling arrangements, and we should give all haste possible to consigning our remaining link and pin drawbars to "innocuous desuetude" and rid ourselves of one source of much expense, which it seems impossible to avoid as long as we are compelled to use the link and pin drawbar to any considerable extent.

Second.—We see that 708 coupler spindles broke, causing trains to part, as compared with only 86 similar cases from broken pockets. From this we are surely justified in unhesitatingly condemning the further use of spindles in all new couplers applied to cars in the future. There is very little excuse for perpetuating the spindle coupler, and as it is shown by the above figures to be an especially weak device, it is the recommendation of your committee that the Master Car Builders' Association put themselves clearly on record, in connection with their recommended practice, against the continuance of the use of spindle rear end attachments for couplers, and in favor of the general use of pocket rear end attachments, which rarely ever give out.

Third.—We notice, in connection with M. C. B. couplers that have caused trains to part, that 906 cases, or 42.04 per cent. have occurred from excessive slack in the draft rigging or improper adjustment of the uncoupling attachments. The result of both of these wrong conditions was clearly shown to one of your committee, a few days ago, in riding on a passenger train watching a freight train going in the same direction on a parallel track of a neighboring road. In this train were a large number of cars equipped with M. C. B. couplers; on at least 50 per cent. of these cars the draft springs were compressed to such an extent and the uncoupling attachments were so short that the connection between the uncoupling lever and the lock was drawn taut and apparently, in some cases, the lock was partially raised. With such a condition existing it is quite easy to see how the application of the brakes on cars in the rear or a sudden pulling out of the engine might compress the draft springs enough to fully open the lock and allow the train to separate. The condition of the cars on the train above referred to is a condition that the reports tabulated above would indicate as existing on nearly 50 per cent. of the cars where "break-in-twos" occur. In overcoming these two prolific sources of danger we have one of the most fruitful fields for work. Excessive slack in draft gear must be overcome by the exercising of greater care in maintaining draft rigging on cars in first-class condition, promptly replacing broken springs, bent followers, springs that have a considerable permanent set and preventing the use of short springs. It should be considered a defect rendering a car unsafe to run if it has 1 inch or more play in the draft rigging, so that by the hand the drawbar can be pushed back or pulled out 1 inch or more. It should also be considered that a car is in improper condition to run when the uncoupling attachments are so arranged that in their released position there is less than two inches slack in the chain connection between the lock and the arm of the uncoupling lever. It is true that a very large percentage of cars running have a less amount of slack in the uncoupling chain. This, in connection with the large number of trains parting, gives a most urgent reason for having a safe limit in connection with the slack in our uncoupling attachments, and your committee would impress upon the representatives of every road in the association the importance of requiring a proper adjustment of the uncoupling attachments and draft rigging on their cars in accordance with the preceding suggestions.

It is noticed that on many cars the end of the lifting arm of the uncoupling lever does not extend out as far as the center of the lock or lock pin; in good practice this should extend a little beyond the center, and attention to this point would materially improve the foundation uncoupling rigging on our freight equipment. In this connection your committee would urge the necessity of inventive genius in designing a simple uncoupling device so constructed that it will not lift the lock and uncouple the car until the coupler has been pulled out three or four inches from its normal position. Such a device would be very beneficial in overcoming a large number of cases of uncoupling due to improper adjustment of uncoupling attachments and excessive slack in draft gear.

Fourth.—The second largest source of trains parting in connection with M. C. B. couplers is due to broken or defective locks: this cause accounts for 886 cases, or 41.11 per cent. It is unquestionably true that the locks now in use in most of the M. C. B. couplers are not all that they should be. Many of them are so constructed that they will creep up by the peculiar pinching action produced by the motion of the car; many of them, dependent upon gravity, are lifted from their proper position by sudden blows which may be caused by the trains slacking up. These and other defects which have developed in the large majority of locking devices, supplemented by the expressions from the representatives of nearly every one of the roads heard from by your committee, warrant the committee in stating that it believes it necessary that coupler locks should be provided in some simple and effective way with a positive lock, which will prevent their being lifted from their locked position by any of the shocks, jars or motions produced in running cars; in other words, that there should be a lock to a lock.

Fifth.—The preceding table shows that 195 cases, or 9.05 per cent. of all cases, of uncoupling of M. C. B. couplers were due to worn knuckles. In view of the rapid increase in the number of M. C. B. couplers in use, and the fact that a large part of them have been in service long enough for the knuckles, and possibly the couplers themselves, to become considerably worn, and as it has been clearly shown that knuckles and couplers worn beyond a certain limit will permit of the knuckles passing the locks or the cars becoming separated without the knuckles opening, therefore your committee would recommend that during the coming year an investigation be made by a committee appointed for that purpose as to the limit of safe wear that can be allowed in knuckles and couplers, with a view of recommending to the association some simple and practical method for inspectors and others to use in determining when M. C. B. couplers and knuckles have become worn or distorted beyond the safe service limit.

In conclusion the committee would call attention to 168 cases, or 7.79 per cent., of uncoupling between M. C. B. couplers due to miscellaneous causes. Most of them can be assigned to broken couplers or knuckles. By the rules of interchange and the decisions of the arbitration committee, it has been declared that M. C. B. knuckles and couplers can be broken without any unusual rough handling. As the breakage of an M. C. B. coupler represents a loss of from $5 to $8, it behooves railway companies to protect themselves as far as possible against unnecessary damage of this kind, not only from the standpoint of doing so to prevent cases of trains parting, but from the standpoint of the cost of renewing such couplers when they are broken.

And in this connection your committee would recommend for the consideration of the roads representing the association, the application to their cars of either rigid or, preferably, spring buffer blocks. The use of such buffer blocks under severe tests in collisions has conclusively proven that both the couplers and the draft rigging are protected and saved to a very large extent where the blows are taken by double buffer blocks, which conduct the shocks through the car and train in a line with the floor timbers and sills.

Steel Underframing for Freight Cars.

Joint report of the following five members of the M. C. B. Association: J. N. BARR, C. M. MENDENHALL, R. P. C. SANDERSON, S. A. CHARPIOT and G. R. JOUGHINS.

Replies were received from most of the railroads addressed, and counted by the official votes in the Master Car Builders' Association. The recommendations represented over 760,000 freight cars. The above figure represents a large majority of the total freight cars in use in the United States that are owned by railroad companies. It may be prudent to mention that the reason for not asking for the opinion of private line companies was, that as their cars are mostly for special use, the dimensions they might recommend would not be the most desirable for general railroad interchange service. After the information referred to had all been gathered in, tabulated and distributed to the members of the committee for their consideration, the second meeting of the committee was held, at which the above information, and all that had been written and published in the discussions on the large-car problem at the railroad clubs and in the papers, as well as the action taken up to that time by the traffic associations, were given careful and thoughtful consideration, as the result of which the committee came to the conclusion that the designs to be presented by them to the convention this summer should be governed by the following conditions:

First, the inside length should be 34 feet for a standard box car of 60,000 pounds capacity. The vote for this particular length and 34 feet 4 inches being 509,000 cars, while the only other dimension receiving a vote of any considerable strength was 36 feet, which received 90,000 votes.

Second, the inside width should be 8 feet 4 inches for a standard 60,000-pound capacity box car.

Third, the height from the top of the floor to the top of plate should be 7 feet 6 inches for a standard 60,000-pound capacity box car.

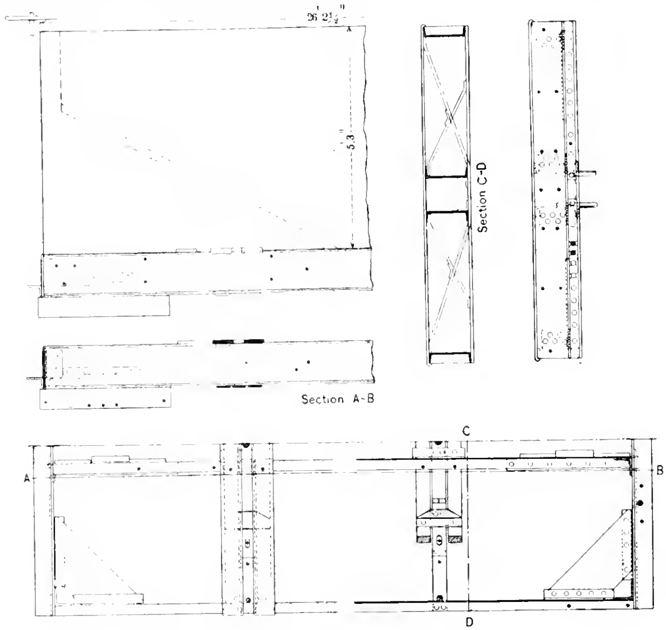
Fourth, the width of the side door should be 5 feet 4 inches clear for all box cars.

Fifth, the end doors, if any are used, should be 24 inches wide by 36 inches high.

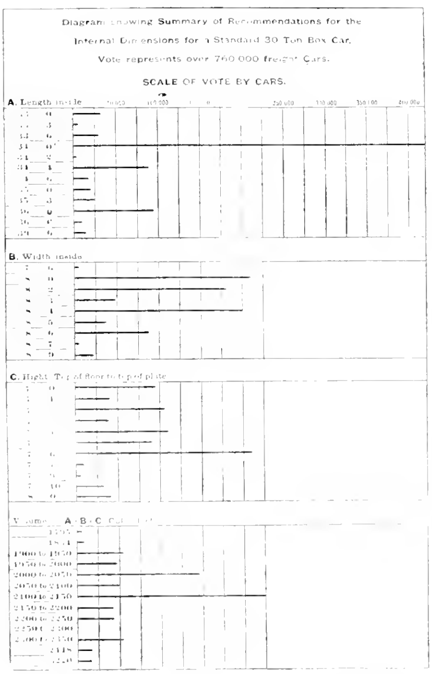
Sixth, the height from the top of the rail to the top of the floor should be 4 feet 2 inches.

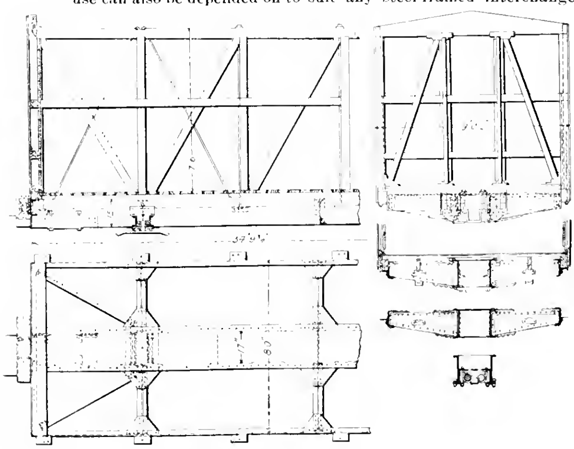
Seventh, the design should show the end sill flush and not projecting beyond the siding.

It is particularly desirable, whatever design of steel underframe be adopted as standard or as recommended practice of your association, even if the detail of the fastenings and less important parts be left to the individual choice of the builder, that the length, section and weight of the main sills, end sills, draw gear and bolster be shown on the association's drawings, so that the rolling mills and car builders who wish to take up the question of manufacturing the steel frames for 60,000-pound capacity cars can take advantage of market fluctuations to buy stock when prices are low, with the assurance that the size and length of sills will surely be used by any railroad companies ordering freight cars with steel frames and, further, that the stock of sills carried by railroads for their own use can also be depended on to suit any steel-framed interchange freight car that may be damaged on their line. Therefore, in presenting these drawings for the criticism, choice, and, we hope, approval of your association, we earnestly urge that the dimensions for a standard interchange freight car mentioned above, to which these drawing have been made to conform, should be submitted to the association by letter ballot, for adoption as standard, and that



Steel Underframe.—Norfolk & Western Railroad.



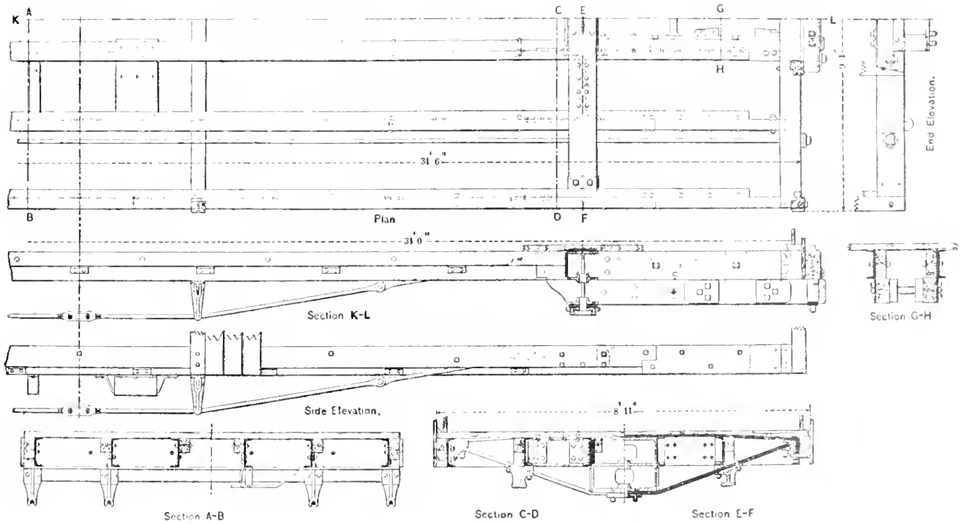


Steel Underframing.—Designed by Mr. R. P. C. Sanderson.

the association will make a choice of one of the designs presented and adopt it or its leading features and dimensions as recommended practice.

Your committee also specially urges that the dimensions recommended for standard interchange box cars, as far as length of sills, width and height from the rail are concerned, should be also adopted for other flat-bottom freight cars of 60,000 pounds capacity, such as stock, gondolas and flat cars, so that the same standard steel sills, bolsters, end sills and draft gears will suit for all these classes of cars of the same capacity.

With reference to the question of increased capacity of freight cars for general interchange service, your committee requested the railroads to give it their recommendations for the size of a standard box car of greater capacity than 30 tons. The replies received indicate that the great majority of the motive power officers of the railroads were not prepared to consider a car of greater capacity than 30 tons for general interchange service. A few sent recommendations for such a car, and of these only one or two recommended dimensions any larger than those they had recommended for 30-ton cars. It is probable that with the general introduction of steel framing for freight cars a greater capacity than 30 tons will be found to be economical, especially where loads can be obtained in both directions, and that the objection to, or unwillingness to consider, cars of greater dimensions than those now used for 30 tons capacity has been brought about by the unceasing trouble caused to the operating departments by the presence of a small number of especially large cars, which are too often used by traffic officers as bids for freight and cause trouble in other ways which have been well ventilated in the recent discussions on the large car problem.



Steel Underframe. Designed by Mr. J. N. Barr.

BILL OF MATERIAL FOR STEEL UNDERFRAMING FOR DESIGN SUBMITTED BY R. P. C. SANDERSON.

Mark.	No.	Name of part.	Length.	Specifications.	Wgt.
A	2	Center sills..........	34 ft. 9¾ in.	15-in. channel C. 1	2,296.5
B	2	Side sills......	34 ft. 9¾ in.	9 in. channel C. 4.	922.4
C	4	Center plate bracket channel...............	17 in.	6-in. channel C. 7.	73.6
D	4	Diagonal braces........	5 ft. 2 in.	4-in. x 2½-in. tee T. 63	150.6
E	4	Center plate bracket angles...........	14 in.	5-in. x 3 in. angle A. 263	46.4
F	16	Side bracket angles ...	9 in.	5-in. x 3-in. angle A. 263	120.0
G	20	Center sill corner angles.......	12½ in.	2½ in. x 2½ in. A. 48	124.8
H	20	Side sill corner angles..	7 in.	2½ in. x 2½ in. A. 48	70.0
I	4	End sill angles.........	2 ft. 9¾ in.	2½ in. x 2¼ in. A. 48	67.4
J	4	End sill angles....	17 in.	2½ in. x 2½ in. A. 48	33.8
K	4	Dead block angles	10 in.	2½ in. x 2½ in. A 48	19 9
L	16	Cross-girder top angles	2 ft. 9¾ in.	2½ in. x 2½ in. A. 48	269.7
M	16	Cross - girder bottom angles....	3 ft. 1 in.	2½ in. x 2½ in. A. 48	295.7
N	2	Bottom cover plate stiffening angles.....,	17 in.	2½ in. x 2½ in. A. 48	16 9
O	1	Top cover plate, 33 ft. 5¼ in x 24 in. x ¼ in.......			675.3
P	1	Bottom cover plate, 17 ft. 6 in. x 24 in. x ¼ in........			353.5
Q	2	End cap plates, 8 ft. x 8 in. x ¼ in.........................			107.7
R	2	End plates, 8 ft. x 10½ in. x ⅜ in......			211.1
S	2	End sill reinforcing plate, 3 ft. 1 in. long. ⅜ in. thick.			105.7
T	4	End plate packing strips, 6½ x 3 in. x ⅜ in.			8.2
U	2	Center plate bracket plates, 2 ft. x 18 in. x ¼ in.			60.6
V	16	Center sill gusset plates, ¼ in. thick....			202.0
W	8	Side sill gusset plates, ¼ in. thick.			67.0
X	8	Cross-girder web plates, ¼ in. thick.............			203.6
Y	4	Draft chafing plates, 3.1 in. x 6½ in. x ⅜ in..			100 3
					6,601.0
		Add for rivet heads........			358 0
		Weight of steel frame			6,959 0

Note.—Letters under the column for specification refer to the Carnegie standard sections.

These difficulties, however, can be entirely overcome, it is believed, by the adoption of a standard cubic capacity per ton of 2,000 pounds for interchange box cars, assisted by the revision of the minimum freight rates by the traffic officers, which can be based on this standard unit of capacity per ton. It is, therefore, further recommended that the figure of 70 cubic feet per ton of 2,000 pounds for the capacity of freight box cars should also be submitted to the association by letter ballot for standard, this figure conforming with the dimensions for the box car mentioned in the early part of this report and to conform to which these drawings have been prepared.

A diagram is also submitted showing roughly the result by votes of the recommendations for the length, width and height for a standard interchange box car, which is presented for the earnest consideration of the members and may aid them in agreeing on standards for these important dimensions.

DESCRIPTION OF STEEL UNDERFRAMING FOR BOX CARS SUBMITTED BY J. N. BARR.

In making the design for underframing of box cars, it has been the intention of the designer to meet certain requirements which do not come into consideration at all in the design of stationary metallic structures, but which appear to be of extreme importance in car construction. In the usual conditions of service, cars are constantly subjected to severe and often destructive shocks longitudinally at the middle point of the end, or at the location of the draft arrangements. In addition to the local damage resulting from these shocks, a tendency to distortion of the framing is caused, whereby the middle longitudinal sills, or center sills, move in one direction, and the intermediate and outside sills move in the opposite direction. This differential motion must be resisted, and if resisted by a very rigid and inflexible construction will result in injury and gradual destruction to the framing.

Cars are also subjected to frequent damage at the ends, and it is important to provide for ready and cheap repairs at this location, so that removal of parts may not involve the general framing of the car.

In the construction presented it is sought to provide for these requirements:

First.—The general frame is flexible longitudinally.

Second.—The end of the framing is so constructed that in ordinary cases of damage repairs can be made without affecting the general framing.

Third.—The means of attachment of draft rigging to car is readily removed without disturbing the general framing

Longitudinal flexibility is obtained by avoiding all diagonal bracing and gussets by making the fastenings between sills as shown at *A*, so that a distortion will bend the fastening *A* and not shear the rivets, and by providing for longitudinal binding rods, *B*, running full length of the car.

The general framing is protected from damage by being discontinued 9 inches from inside of end sill. The end sill is carried by short wooden sills fastened to the through iron sills.

The draft timbers are fastened to iron plates which extend from the end sill to the transom. This plate can be removed without disturbing the general framing.

Vertical strength at the center of the car is secured by truss rods as shown.

It is not necessary to enter into a general description of the framing, which is already shown by the drawing.

DESCRIPTION OF STEEL UNDERFRAMING FOR CARS.
SUBMITTED BY G. R. JOUGHINS.

The ideas governing the designs submitted by me are—

First.—Ample vertical strength.

Second.—Simplicity, avoiding blacksmithing and boilermaking as much as possible.

Third.—No holes in flanges of longitudinal sills.

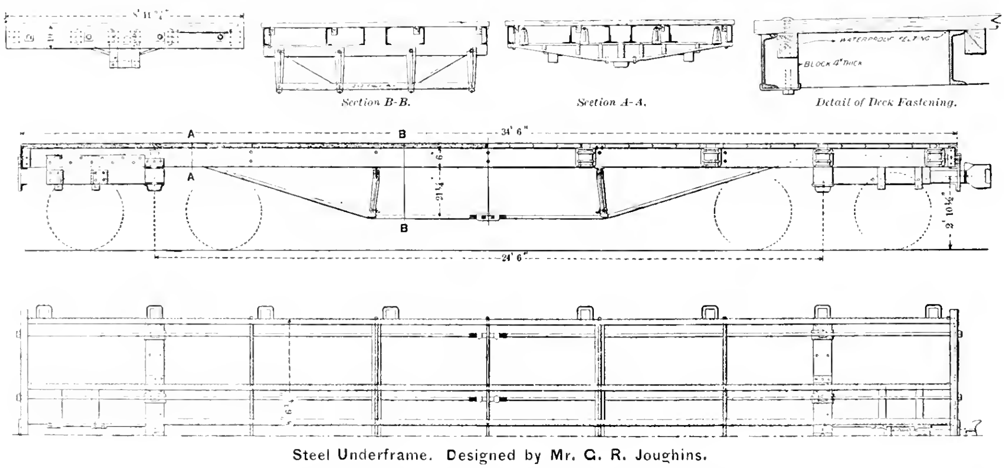
Fourth.—Accessibility for painting, repairs, etc.

Flat Cars and Gondolas.—Several years' experience with flat cars built according to these designs, or more exactly according to the designs of the Norfolk & Southern car illustrated in last year's proceedings, shows only one weakness; that is the tendency of the stakes, when cars are heavily loaded with logs, to twist and distort the side sills. This tendency can be overcome in many ways which will easily be suggested, but it is found that the web of the side sills ought to be $\frac{5}{16}$ of an inch thick to prevent them buckling, and that they must be braced to prevent them from twisting. On gondola cars this weakness would not exist. The platform, made up in four length, easily detachable from the frame, is found to be a great convenience when painting, etc.

Box Cars.—It must be acknowledged that, because the sills are protected from the weather, there is not the same necessity for steel sills on box cars as there is on open cars; moreover, the tops of the sills cannot be so readily exposed for painting. On the other hand, the steel sills would also enjoy protection from the weather, and therefore would not rust so quickly; it is furthermore expected that the great value of steel frames in strength, durability and economy will be so demonstrated by experience with open cars that their use will be universal. The underframe should be sufficiently strong to support the whole weight without assistance from the superstructure; indeed, it is hoped that the design of frame which would be used for flat and box cars will be identical, the only exception being the method of attaching the necessary timber work. The proposed method of attaching the superstructure to the sills is merely a suggestion, pointing out a possible means of connection; the ends particularly require close study.

General.—The designs are intended to convey the general principles advocated, combined with the results of actual experience with steel cars. Longitudinal sills should all be of the same depth to provide uniform support. The weights per foot of sills under cars in use are as follows: Center sills, 15 pounds per foot; side and intermediate sills, 11 pounds per foot; these side sills, although strong enough for vertical load, are too weak to properly hold the stake pockets under severe strains, and therefore the web should be $\frac{5}{16}$ of an inch thick. To conform to the new schedule of sections adopted by the rolling mills these weights should be somewhat increased.

To protect against rust, experience shows that, with untreated iron, periodical painting is absolutely necessary, but that very little rust develops anywhere except upon the tops of the sills on which the timber platform rests. A strip of waterproof felt laid on top of the sills would assist greatly in avoiding rust, and if the felt was cemented down with some compound (possibly P. & B compound), it would probably avoid all rust and the necessity for frequent painting. It might be practicable to have the sills galvanized or laquered to prevent rusting. Draft gear between sills, as shown in the Norfolk & Southern car, is considered to be the best practice, if a satisfactory yoke coupler can be attached. The bolsters shown are not quite perfect—they bend upward immediately above the center plate. The bracing of bolsters to center sills seems to be useful. Poling pockets might be attached on the sides at the bolsters instead of at the ends.



Steel Underframe. Designed by Mr. G. R. Joughins.

Loading Logs, Poles, Bark, Etc.

P. LEEDS, L. P. BUSH, W. H. LEWIS, W. H. DAY, F. H. STARK, B. HASKELL, CHAS. COLLER, P. H. PECK and J. R. PETRIE, committee.

Your committee on the "Loading of Logs, Poles, Bark and Long Structural Material on Cars," sent out a circular inviting criticisms of the rules adopted in 1896, and received 24 replies, 20 of which are to the effect that the rules as adopted are perfectly satisfactory, while the other four find no fault with those rules, but suggest the addition of rules to cover the loading of pipe, tan bark, cordwood, ties, fence posts and dressed lumber. There have also been blueprints received showing the suggested methods for loading logs and pipe as per cuts. The methods proposed for the loading of tan bark, cordwood, ties, etc., conflict to the extent that about one-half advise loading crosswise of the car, and the others lengthwise; but they all agree that this loading, as well as dressed lumber, should be fully staked, and racked at the ends. A request for sketches showing this racking at the end brought replies to the effect that there was such a variety of construction that it would be impracticable to show it by sketch, but that where there were end stakes they should be utilized, and where there were no end stakes there should be cross-pieces from outside stakes nearest the end of car. This brings up the recommendation of the committee last year, that there should be uniformity in the staking of cars, and those stakes should be spaced so as to allow of the recommended practice being complied with. This would, in our opinion, be best accomplished by placing one pocket in the center on the side of the car, and spacing so as not to exceed $3\frac{1}{2}$ feet from center to center of pockets, bringing the center of bolster approximately central between two stakes and placing the end pocket on the side as near the end sill as possible, so that one side of the stake would come in line with the inside of stake through the floor of car at the end, the pockets for which should be bolted to the inside of the inner sill. This staking would allow of sufficient stakes being used when lading was carried on two cars without spreading them to the extent of excessive binding when on a curve, or at least to a greater extent than the construction now prevalent. Where it was recommended that ties, cordwood, etc., be loaded lengthwise of the cars, it was very generally stated that the ends nearest the ends of the car should be raised and placed upon crossbearings securely fastened to the floor of the car. In view of the fact that most of this loading is local and not to any extent subject to interchange, the only recommendation the committee feels called upon to make is that all stone shall be cleated with strips not less than one and one-half inches thick nor less than four inches wide, securely fastened to the floor of the car with not less than one tenpenny fence nail to every nine inches, such nails to be staggered so as to be within one inch of the edge of the strip alternately. That lumber, dressed on one or both sides, when loaded on gondola or platform cars, must be racked at each end of the car in such a manner as to prevent the load from shifting. That all flat cars should have pockets applied in such a manner that the two end stakes and two side stakes at each end of the car can be utilized for this purpose. As regards the proposed methods of loading logs and pipe, while your committee fully approves of the pyramid methods, as shown, it prefers to submit the matter tentatively, and whichever (if either) method is approved by the association, prepare descriptive rules and present them for considera-

tion at a later day during this session. [A supplemental report was presented, which was based upon exceptions taken to the rules by the manufacturers of long structural material and inspectors handling the material.—EDITOR.]

Joint Report of Committees on Revision of Air Brake and Signal Instructions.

The report of this committee is in the form of the air brake and signal instructions with certain italicized additions. A new illustration was introduced to show the modern engineer's valve and the handle of the valve is shown in running instead of release position as formerly. Several of the other drawings have been modified in minor details. Some qnestions principally referring to the straight air brake have been ommitted entirely.

Box-Car Side and End Doors.

J. J. HENNESSEY, C. A. SCHROYER, GEO. F. WILSON, G. N. DOW and ROBT. GUNN, Committee.

Roads representing 180,000 box cars were in favor of the common batten door, while the balance of the roads were divided between the frame and flush doors. Roads representing 90,000 box cars were in favor of an overhung door with roller hangers, not patented. The balance of the roads, representing 112,000 box cars, were divided between the different patented hangers and the common slide hangers.

Your committee, after careful consideration and considerable labor, attempted to design an ideal box-car door, and at one time thought this accomplished, but after submitting the design to the Western Railway Association, it rendered a decision that the design was infringing on some patent rights. Judging from the replies received to the circular of inquiry a large minority, were in favor of an overhung door with roller hangers, not patented, while the majority of the roads which were in favor of the patented devices did not seem to agree on any particular device.

Your committee, therefore, submits the following designs for box car side and end doors, which it thinks will answer all practical purposes:

The side and end doors to be hung by two cast or malleable iron hangers to each door, each hanger secured to the door by three ⅜-inch carriage bolts and two ⅝-inch dowels, tapering to ½ inch. Each hanger to be supplied with a chilled cast-iron roller fitted into the hanger. The top rail to be ⅜ by 2½ inches wide, backed by a piece of oak running full length, being about 1½ inches horizontally and 1⅜ inches vertically, the rail to be fastened to this oak strip and through side or end plate by ½-inch countersunk bolts, about 20 inches apart.

The lower edge of door to have an iron rail ⅜ by 2½ inches, rabbetted flush into the lower cleat and projecting 1 inch below bottom edge of door, and fastened with button-head countersunk rivets ⅜-inch in diameter, passing through the ⅜-inch iron rail, bottom cleat and sheathing of door. These rivets to be about 18 inches apart; also two button-head rivets, ½-inch in diameter, passing through the ⅜-inch iron rail, ⅝-inch from bottom of rail, and so located that the button heads will come in contact with the door brackets when door closes, thereby holding door tight against car body when door is closed. The cuts accompanying this report fully illustrate the style of brackets to be used and location of same.

It is the opinion of your committee that it would be useless to recommend a standard size of door, as the door will have to correspond with the door openings of the various sizes of box-cars. The recommended door, however, is the common batten door, with three pine cleats 10 inches wide, and located at top and bottom edges and center of door on the inside, and filled in on the two side edges by filling strips 5½ inches wide, the door to lap 2 inches on closing side against an oak stop strip, running full length of door and fastened to the door post by ½-inch lag screws, the door to lap on door post on opposite side of door at least 4 inches. The door fastenings for seal to be the common hasp and eye bolt, in connection with the seal pin and tin seal, and located a suitable distance from bottom edge of door.

Taking everything into consideration your committee is of the opinion that the most practical end door fastening is that which fastens on the inside, requiring no seal, thereby saving considerable labor to the sealing clerks and the trainmen.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

Abstracts and Summaries of Reports Presented at the Thirtieth Annual Convention.

Ratios of Grate Area, Heating Area and Cylinder Volume.

G. R. HENDERSON, A. S. VOGT, R. WELLS, S. M. VAUCLAIN and C. J. MELLIN, committee.

In order to present an analytical discussion of the question, it was necessary to determine approximately the following points:

1. The force necessary to move a train of a given weight at various speeds and accelerations over various grades and curves.
2. The ratio of mean effective pressure in the cylinders to initial pressure, for various speeds, cut-offs and lengths of steam port.
3. The ratio of cut-off pressure to initial pressure for various speeds, cut-offs and length of steam port.
4. The evaporative value of different fuels at various rates of combustion per square foot of heating surface.
5. The evaporative value of different fuels at various rates of combustion per square foot of grate area.

It will be at once recognized, that if we are able to satisfactorily determine these various points, the proper heating surface and grate area needed by a locomotive for doing a definite amount of work can be readily calculated.

First, considering the subject of Train Resistance. After much research it was decided that the resistance due to speed was perhaps best represented by the formula published in *Engineering News*, of June 9, 1892, which is:

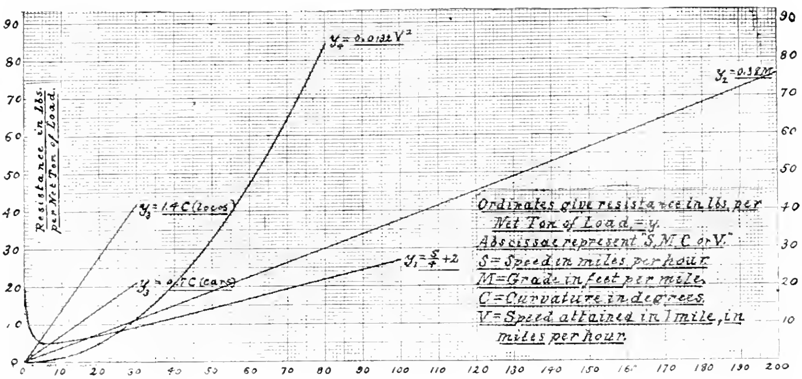


Diagram No. 1.—Train Resistance Curves.

$$y_1 = \frac{S}{4} + 2,$$

where y_1 = resistance in pounds per net ton of load,
S = speed in miles per hour.

The force for starting is, however, about 20 pounds per ton, which falls to 5 pounds as soon as low rate of speed is reached.

The resistance due to grades is expressed by

$$y_2 = 0.38\,M,$$

where y_2 = resistance in pounds per net ton of load.
M = grade in feet per mile.

The resistance due to curves is generally taken at from 0.5 to 0.7 pounds per ton per degree of curvature. Selecting the latter value, and assuming that locomotives, on account of their long rigid wheel base, produce double the resistance of cars, we have

$$y_3 = 0.7\ C \text{ for cars,}$$
$$= 1.4\ C \text{ for locomotives,}$$

where y_3 = resistance in pounds per net ton of load.
C = curvature in degrees.

It may also be desirable to consider the resistance due to acceleration of the speed of the train, and it is found that this can be expressed by the formula

$$y_4 = 0.0132\ V^2$$

where y_4 = resistance in pounds per net ton of load,
V = speed attained in one mile, expressed in miles per hour, starting from rest.

Diagram 1 gives a graphical representation of all these formulæ for convenient use.

Diagram No. 2 gives the ratio of mean effective pressure to initial pressure for various cut-offs and speeds. The shaded zones or belts are intended to represent the limits of port length between which we are likely to work in locomotive construction. For instance, the upper portion of a zone represents what may be expected when using an Allen valve, or when the length of port in inches bears approximately the ratio 0.12 to the area of the cylinder in square inches, and the lower portion when the ratio is approximately 0.05. This diagram was constructed by taking some of the data in the report of the Committee on Slide Valves, found in last year's proceedings of this Association.

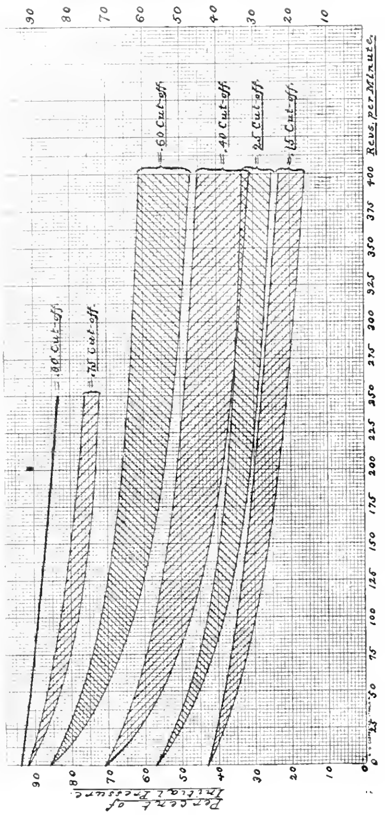


Diagram No. 2.—Ratio Between Mean and Initial Pressures.

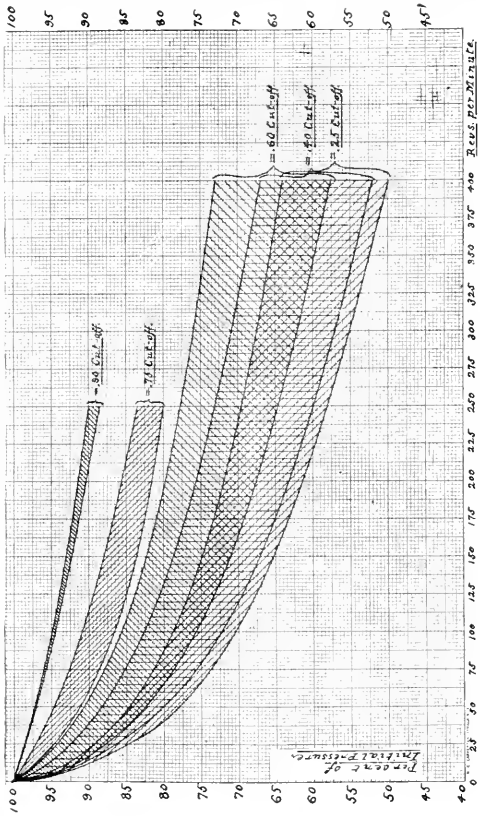


Diagram No. 3.—Ratio Between Cut Off and Initial Pressures.

Diagram No. 3 gives similar information in regard to the cut-off pressures, and the explanation above will answer for this also. Your committee wishes to state that diagrams 2 and 3 have been verified as far as possible, with gratifying results. A clearance of 8 per cent. was allowed in computing these curves, and the pressures are all "above the atmosphere." It is with some hesitation that diagrams 4 and 5 are presented, as there are so many varying conditions in coal trials that any diagrams of this kind can be but the merest approximations. However, as they may be of some interest, diagram No. 4 is given to represent the evaporative value of fuel at different rates of combustion per square foot of heating surface per hour, and No. 5 the same at different rates of combustion per square foot of grate area per hour.

The individual curves designate some one kind of coal, or test of same. The following table will interpret the several curves:

INDEX TO EVAPORATIVE VALUE OF FUELS, DIAGRAMS 4 AND 5.

No.	Location of Mine.	Kind of Fuel.	Ratio of Heating Surface to Grate Area.
1	Pennsylvania	Anthracite, large.	45
2	"	" "	20
3	"	" fine.........	20
4	"	" "	20
5	"	Semi-bituminous.........	70
6	"	"	84
7	Virginia	"	66
8	"	"	57
9	"	"	49
10	Illinois....	Bituminous...........	50
11	"	"	55
12	"	"	71

No. 13 had a ratio of heating surface to grate area of 100, but the kind of fuel is not positively known—it probably resembled a lignite.

No. 14 represents Professor Goss' experiments with diminishing grate areas.

Nos. 15, 16 and 17 represent the experiments of the Paris, Lyons & Mediterranean Railway, made a few years ago with various lengths of tubes, the dimensions being 10 feet, 15 feet and 20 feet, respectively.

It would appear, from a study of these diagrams, that there is a loss in efficiency of fuel by increasing the rate of combustion per square foot of grate area per hour, which is chiefly accounted for by the unburnt coal which passes out of the stack, and which loss is represented by curve 14; and a loss by increasing the rate of combustion per square foot of heating surface per hour, which is due to the fact that the gases pass over the heating surfaces more quickly, and which is partly represented by curves 15, 16 and 17. Under the conditions which exist in ordinary locomotive service, therefore, we may expect a steeper curve, occasioned by the loss in efficiency from both causes, and it will be seen that most of the curves have this increased slope.

From these diagrams it is patent that results widely apart can be obtained with the same coal, and, therefore, your committee considers that the best way to attempt to represent the value of fuels will be by zones instead of single curves. The upper portion of the zone may be taken to give the values of good grades of fuel under favorable conditions, and the lower portion when circumstances are not so favorable. This zone may be subdivided for different kinds of coal, and the diagrams show what is considered a fair division in this respect. This, of course, applies only to the proportions usually found in locomotive boilers. It would appear from diagram No. 4, that a poor coal might be made to yield almost as much economy as a better coal, if the rate of combustion were properly reduced. This shows that, in general, the boiler of a locomotive should be as large as possible, being limited only by the weight which is allowable and the clearances of the railroad, and that in designing a locomotive every part should be made as light as possible, consistent with strength, and the boiler, or really the water in the boiler, should utilize every surplus pound of weight available.

FACTOR OF EVAPORATION.

As the factor of evaporation for the pressures and temperatures of feed-water usually occurring in locomotive practice varies between 1.15 and 1.25, we may consider 1.2 as an average value.

INTERNAL FRICTION.

Wellington places the internal friction of the locomotive (not including the journal and rolling friction) at from 5 to 8 per cent. of the indicated power; Forsyth (C., B. & Q.) at 10 per cent.; and *Engineering News* (Vol. 27, page 585) at 5 per cent. It may, therefore, be assumed at from 5 to 10 per cent. of the indicated power, or in

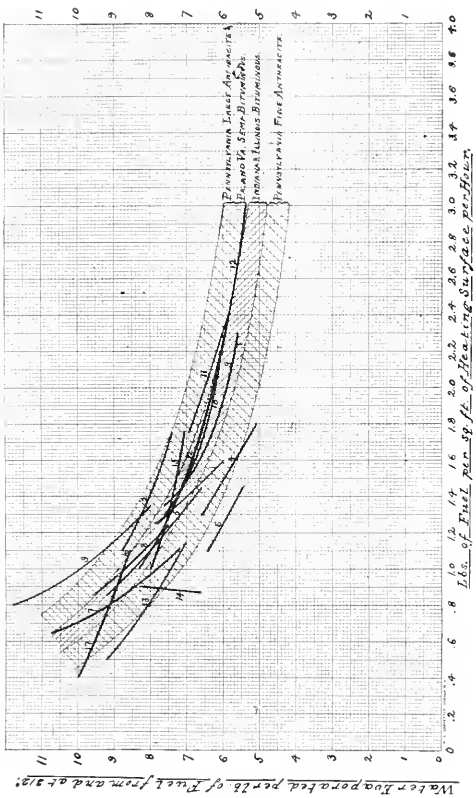


Diagram No. 4.—Evaporative Values of Fuels.

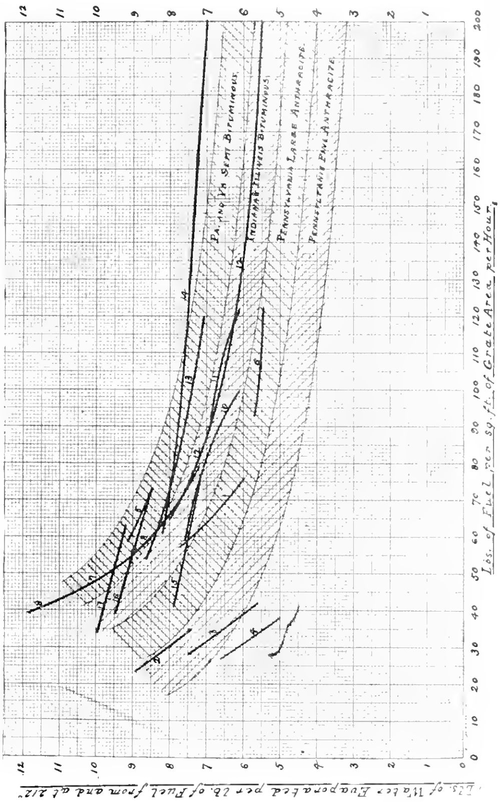


Diagram No. 5.—Evaporative Values of Fuels.

round numbers the theoretical tractive force (indicated tractive force) may be taken as 10 per cent. greater than the actual tractive force, which actual tractive force is utilized not only in drawing the train, but in overcoming the journal and rolling friction of the engine and tender as well, these to be taken at the same rate as the train itself.

TRACTIVE FORCE.

As is well known, the theoretical tractive force is represented by the equation:

$$\text{Theoretical tractive force} = \frac{pd^2 s}{D} \text{ in pounds}$$

where p = mean effective pressure in pounds per square inch,
d = diameter of cylinder in inches,
s = stroke in inches,
D = diameter of driving wheel in inches.

From what we have seen above, we can therefore write

$$\frac{pd^2 s}{D} = 1.1 (y_1 + y_2 + y_3 + y_4) T$$

where T = weight of train in net tons, including the engine and tender, and y to be taken from Diagram No. 1.

The mean effective pressure depends principally upon two factors, the boiler pressure and the cut-off, modified by the initial pressure and the speed, which reduces the cut-off pressure below the initial. While the mean effective pressure fixes the tractive force, yet the actual cut-off pressure bears an important effect upon the tendency to slip the wheels at different parts of the revolution.

If we consider the friction between the wheels and rail to be 22 per cent. of the adhesive weight, and a loss of 10 per cent. due to the internal friction of the engine, we can conclude that the theoretical rotative force at the circumference of the wheel must never exceed 25 per cent. of the weight on the drivers.

The point of maximum rotative force varies 15 degrees each side of the 45 degree point.

To prevent slipping we may therefore conclude that the average tractive force should not exceed 22 per cent. of the adhesive weight, as this would prevent the maximum rotative force exceeding the 25 per cent. found above, in all but the $\frac{1}{3}$ and $\frac{1}{4}$ cut-off, and as the speeds are generally high at these points, the inertia of the wheels, etc., would probably prevent slipping at the maximum points.

In 1887, a committee of this association advised that the coefficient of friction between the wheel and rail might be taken at 25 per cent. for passenger and 23 per cent. for freight locomotives. This committee also recommended using the diameter of wheel when the tire was half worn, instead of the diameter when new, in figuring the tractive force. This would give us values of about 24 per cent. and 22 per cent. for passenger and freight, respectively, when the full diameter was used, so your committee accepted 22 per cent. as the proper co-efficient in both cases.

EVAPORATION.

Diagram No. 3 and Tables D and E enable the weight of the steam used per stroke to be determined, and Table B the weight of steam per hour. This, of course, is the "water accounted for by indicator" and should have about 25 per cent. added for condensation and other losses. It should also be multiplied by the factor of evaporation, 1.2, to obtain the amount of water from and at 212 degrees.

EXAMPLES.

Take a 10-wheel engine, 19 by 24-inch cylinder, 60-inch drivers, boiler pressure 150 pounds, 28 square feet grate area, and with 100,000 pounds on drivers. This engine is capable of pulling a passenger train of 300 tons gross weight up a 70-foot grade at a speed of 30 miles per hour, the fuel being Pocahontas coal. From Diagram No. 1 it is found that the value of y_1 at 30 miles per hour is 9, and the value of y_2 on a 70-foot grade is 27, making a total resistance of 36 pounds per ton. Therefore we have (allowing the 10 per cent. for internal friction above referred to) $36 \times 300 \times 1.1 = 11,880$ pounds, say 12,000 pounds total resistance. The mean effective pressure necessary to do this work would therefore be $\frac{12,000 \times D}{d^2 s} = p$ (see formula 2), or $\frac{12,000 \times 60}{361 \times 24} = 83$ pounds M. E. P., and as the initial pressure may be 140 pounds, we find from Table C that the M. E. P. is 60 per cent. of the initial pressure. From Table B it can be seen that a 60-inch wheel makes 168 revolutions per minute at 30 miles per hour, while from Diagram No. 2 it is found that with Allen valves (which this engine uses) a cut-off of about 50 per cent. is necessary. From Diagram No. 3, it appears that with 50 per cent. cut-off and 168 revolutions per minute, the cut-off pressure will be about 78 per cent. of the initial pressure. From Table C this is found to be about 110 pounds per square inch, and Table D gives the volume of a 19-inch cylinder 12 inches long as 1.97 cubic feet, or, say, 2 cubic feet of steam per stroke. Table E shows the weight of steam per cubic foot at 110 pounds pressure

to be 0.284 pound, and allowing the factor of evaporation, 1.2, and the 25 per cent. for condensation, etc., we have:

$$\left.\begin{array}{l}\text{Pounds of water}\\ \text{per hour from and}\\ \text{at 212 degrees}\end{array}\right\} = 2 \times 4 \times 168 \times 60 \times 0.284 \times 1.2 \times 1.25 = 34,352.$$

Now, allowing $6\frac{1}{2}$ pounds water per pound of coal (on account of the high rate of combustion), and also dividing by the 28 square feet of grate area, we have

$$\frac{34,352}{6.5 \times 28} = 189 \text{ pounds of coal per square foot grate area per hour,}$$

which, it will be evident, is about the maximum capacity of the engine.

We will now proceed to illustrate how the amount of heating surface and grate area can be determined from the foregoing data, when the cylinders, wheels, etc., of the locomotive have been decided upon, these, of course having been determined by means of formulæ 1, 2 and 3 and the data following them. To do a certain amount of work we can use a smaller cylinder and cut off later, or a larger cylinder and cut off earlier, the diagrams and formulæ giving the results in either case.

Let us consider first that at the average work (that is, the work performed during most of the run) steam should be used at the most economical rate. This seems to be pretty generally conceded to be at one-fourth cut-off for simple and one-half cut-off for compound locomotives. It is also considered that while the maximum speed of a locomotive in miles per hour will be closely represented by the diameter of its wheel in inches, that the average speed at which it does most of its work will be about half that speed, or at 168 revolutions per minute. (Our figures now refer to passenger locomotives only.)

Cut-off at one-fourth stroke and 168 revolutions give by Diagram No. 3 a cut-off pressure of about 70 per cent. of initial pressure, which, if we assume to be 160 pounds, will give us 110 pounds at cut-off, weighing 0.284 pound per cubic foot.

Letting Vt = the volume in cubic feet of both cylinders (that is, 2 × area × stroke), we now have: Water per hour from and at 212 degrees in pounds =

$$\frac{Vt}{4} \times 2 \times 168 \times 0.284 \times 1.2 \times 1.25 \times 60 = 2,147\ Vt \text{ or, say, } 2,150\ Vt.$$

If for freight engines, we assume $\frac{1}{2}$ cut-off and 120 revolutions per minute, we have nearly the same result, namely, 2,150 Vt.

So far we have proceeded without any reference to the fuel used, but now we must make more assumptions, and decide that an economical rate of evaporation should be maintained under the above conditions. From Diagrams 4 and 5 it appears that large anthracite will evaporate 8 pounds of water per pound of coal, when the rate of combustion is $1\frac{1}{2}$ pounds per square foot heating surface per hour and about 60 pounds per square foot grate area. This will give, for large Pennsylvania anthracite coal,

$$\text{Heating surface in square feet} = \frac{2,150}{8 \times 1.5}\ Vt = 180\ Vt.$$

$$\text{Grate area in square feet} = \frac{2,150}{8 \times 60}\ Vt = 4.5\ Vt.$$

In ascending heavy grades the fires will be forced to two or three times the rate specified above, in which case the cut-off may be 0.5 or 0.6, or even 0.75 of the stroke, thus greatly increasing the work of the engine, as we saw in the first two examples. Of course there is a limit to the rate of combustion, which seems to be about 200 pounds per square foot of grate area per hour for bituminous coal. Your committee could not ascertain the limit for anthracite coal, but it is evidently much lower.

The circles denote engines which were reported as indifferent steamers.

In all the foregoing calculations, we have based our figures on simple or single expansion engines only. In compound locomotives, the consumption of water will be about 10 per cent. and of fuel about 20 per cent. less than in simple engines.

In calculating the quantity of steam used, the volume Vt should, of course, include only the high-pressure cylinder or cylinders.

Your committee could find no reliable data on the relative value of firebox and tube-heating surface, some authorities assuming that the former was worth twice, and some ten times the latter. It will be seen to average in amount about 10 per cent. of the total heating surface.

The ratio of tube length to outside diameter is also important, and recently much longer lengths have been in vogue. The average seems to be about seventy diameters, although in the Paris, Lyons & Mediterranean Railway experiments, 90 diameters gave the most economical results, and this proportion is gradually coming into American practice.

CONCLUSIONS.

After a careful study of the foregoing data, your committee has reached the following conclusions:

The ratio of grate area in square feet to total cylinder volume in cubic feet should not be less than:

4 for large anthracite coal,
9 " small " "
3 " bituminous "

for simple passenger or freight locomotives.

The ratio of heating surface in square feet to total cylinder volume in cubic feet should not be less than:

180 for large anthracite coal,
200 " small " "
200 " bituminous "

for simple passenger or freight locomotives.

(The proportion for compound locomotives must be figured out by taking the volume of the high-pressure cylinder or cylinders and the desired cut-off in high pressure cylinder, and calculating as in formula 4.)

The ratio of heating surface to grate area should not be less than:

40 for large anthracite coal,
20 " small " "
60 " bituminous "

for passenger and freight locomotives.

For coke and fuel oil the proportions for bituminous coal may be observed.

The ratio of firebox heating surface to total heating surface should be about 10 per cent.

The ratio of tube length to outside diameter should not be less than 70, and may be as much as 90.

The ratio of steam port length in inches to cylinder area in square inches for passenger locomotives should be preferably about 10 per cent. This can be accomplished either by using piston valves or Allen valves. In the latter case the Allen valve has been considered as doubling the length of the port. In freight locomotives, which naturally make less revolutions, the ratio may be from 5 per cent to 8 per cent.

Finally your committee wishes to state that their deductions and calculations must always be used with discretion, and in every case the locomotive should be designed for the work it has to do, not merely accepting these general formulæ (4 to 12) for all the varieties of service without modification. The first portion of the report indicates how to proceed with such calculations in detail.

Best Metal for Cylinders, Valves and Valve Seats.

J. N. Barr, G. F. Wilson, G. W. Stevens, F. W. Morse and H. Lundy, committee.

The question of the strength of locomotive cylinders is an extremely complicated one. It would be possibly more correct to define this as a question of the liability of locomotive cylinders to break in service. The tendency of a cylinder to break is only partially dependent upon the strength of the material of which it is composed. The form, the pattern and the shrinkage of the material from which the casting is made are the points upon which the tendency to breakage most largely depends. Owing to the fact that strains from shrinkage cannot be entirely avoided, the question of the shrinkage of the metal from which the casting is made becomes of paramount importance. It will readily be admitted that if the metal in the cylinder shrinks one-sixteenth of an inch to the foot in cooling, the internal strains will be much less than if the metal used should shrink one-eighth of an inch to the foot. It is therefore of the utmost importance that the metal selected for cylinders should show the least possible amount of shrinkage. The various kinds of pig iron differ materially in this respect, and in the same brand of pig iron the amount of shrinkage varies materially with the grade of the iron, the rule being that the higher the grade or the harder the iron the greater will be the shrinkage of the casting made therefrom.

It is necessary to consider the question of hardness directly in connection with that of shrinkage. The metal composing the cylinder must be soft enough so that the boring and planing operations can be properly performed. The easiest and most accurate way of determining the hardness of a metal is to pour from the metal, when molten, a chill test—that is, to pour a small casting so that a portion of the casting is formed against an iron chill. Unless iron is extremely soft there will be found on breaking the casting a certain depth of white iron formed against the chill, and the depth of this white iron will vary directly as the hardness of the metal from which the casting is made. If a casting is made from a metal for which the chill test shows a depth of about one-half inch of white iron, the casting can be comfortably worked on the planer and boring machine. If, however, the chill test shows a depth of three-fourths of an inch white iron, it can be worked with considerable difficulty, although when wheels are made with a metal of this hardness, or even harder, they can be bored with reasonable facility. This, however, depends also upon the brand of metal which is used. With certain mixtures of iron, a chill test showing one-half inch will indicate a casting which is very difficult to work. But, without going into these fine details, a chill test of one-half inch white iron will give a casting, which in the shape of a cylinder can be satisfactorily put through the ordinary machining operations.

If the iron chills materially deeper than this, the difficulty of machining will be so great as to condemn the casting. Even if the casting could be machined the excessive shrinkage of such hard metal would cause serious trouble from cracking of the cylinders in service.

When we consider the question of friction, both in the case of the cylinder itself and the valve seat, there seems to be no reason to hesitate in saying that the harder the wearing surface the better the results, both as to wear and frictional resistance. This is undoubtedly true within the limits of a cylinder casting, and is possibly true within any limit. The problem, therefore, in the case of a cylinder composed of one piece narrows itself down to that of providing the hardest possible cylinder consistent with the necessary freedom from breakage, and with machining requirements.

It is believed by your committee that the chill test described above is an accurate indication of the hardness of the iron, and that $\frac{1}{2}$-inch depth of white iron, or, as it is generally expressed, a "half-inch chill," represents the extreme of hardness permissible in a cylinder casting.

A shrinkage test could be made by casting a square bar $1\frac{1}{2}$ inch in cross-section and 2 feet long, casting the ends of this bar against iron chills placed accurately 2 feet apart. The length of the bar, when cold, will represent the shrinkage tendency of the mixture used. This test should always be made in combination with the chill test, as the same iron will show less shrinkage when chilling $\frac{1}{4}$-inch than when chilling $\frac{1}{2}$ inch.

In the matter of metal for valve seats, the question is—"Should the metal for valve seats be the same or different?"

A number of tests have been made of brass slide valves, and, so far as your committee have been able to ascertain, the results have been unsatisfactory as compared to cast-iron, both as to frictional resistance and wear. Your committee cannot do better on this point than to quote from Joshua Rose as follows: "Cast-iron in some situations is far more durable than hardened steel; thus when surrounded by steam it will wear better than will any other metal. Thus, for instance, experience has demonstrated that piston rings of cast-iron will wear as smoothly, better and equally as long as those of steel, and longer than those of either wrought-iron or brass, whether the cylinder in which it works be composed of brass, steel, wrought-iron or cast-iron; the latter being the most noteworthy, since two surfaces of the same metal do not as a rule, wear or work well together. So also, slide valves of brass are not found to wear so long or so smoothly as those of cast-iron, let the metal of which the seating is composed be whatever it may; while, on the other hand, the cast-iron slide valve will wear longer of itself and cause less wear to its seat, if the latter is of cast-iron, than if of steel, wrought-iron, or brass."

If greater hardness is desired in the wearing part of the cylinder and valve seats than is consistent with the strength of the body of the cylinder, the same can be secured by the use of bushings and false valve seats, and this course is recommended by a number of members.

In conclusion your committee recommends:

1. That as a rule cylinders should be as hard as is consistent with machining requirements.
2. That the matter of shrinkage should receive close attention in making cylinder mixtures.
3. That members having the facilities should make systematic tests of the hardness, shrinkage and strength of metal used in cylinder castings and supplement the same with chemical analyses.
4. That valves should be of cast iron.

Counterbalancing Locomotives.

E. M. Herr, S. P. Bush, W. H. Lewis and C. H. Quereau, committee.

In accordance with instructions your Committee on Counterbalancing designated 11 railroads to confirm or disprove our recommendations in the report submitted at the 1896 meeting. Of these 11 roads only four have reported, viz.: Pittsburg, Cincinnati, Chicago & St. Louis, Northern Pacific, Chicago, Burlington & Quincy, Louisville & Nashville.

In every case the report has been favorable, all concurring in the opinion that the engines tested rode at least equally well when balanced by the rule recommended as by the usual rule of balancing two-thirds of the reciprocating weights, regardless of the weight of the engine.

The engines tested were of different types, from 8-wheel, mogul and 10-wheel engines in fast mail and passenger service to heavy consolidation engines in fast freight service. In order, if possible, to be able to present more data than could be obtained from the roads designated, requests for information of the action of engines balanced in accordance with the rule recommended by the committee were sent to forty-five other roads; nineteen replies were received, of which only six have tried the committee's method. In none of these were any bad results reported from the use of the rule recommended, two reporting that a larger proportion of the total weight of the engine than $\frac{1}{400}$ could be taken as the allowable weight of the reciprocating parts on each side which could be left unbalanced.

One member reports $\frac{1}{300}$ as giving good satisfaction in an 8-wheel engine in fast passenger service. Another recommends using the rule recommended by this committee for short engines and increasing the unbalanced weight in proportion to the length of the engine.

From the result of actual tests on a number of different roads with differnt kinds of locomotives, and the further fact that the rule recommended coincides almost exactly in many well-designed engines with the method of counterbalancing long in common use and has received the indorsement of every road which has tried it, your committee has to report that the results obtained show that the principle upon which the rule is based is correct, and indicate that if the proportion of unbalanced weight allowed is incorrect it is on the safe side or too small, and that in any except very high speed engines a larger proportion of unbalanced reciprocating weight might safely be allowed.

The recommendations of the committee might be criticised because the greater unbalanced reciprocating weight throws greater stresses on the frames and adjacent parts. The stresses from which the track is relieved by increasing the unbalanced weight of the reciprocating parts are, of course, thrown upon the frames and other parts of the engine itself. It is readily shown, however, that the stresses from the amount of unbalanced weight allowed by the rule recommended at the assumed maximum speed of as many miles per hour as the diameter of the drivers contains inches, will be only one-third or one-fourth, in ordinary types of locomotives, of the stresses thrown upon the frame by the pressure exerted by the steam against the piston. Furthermore, the greatest stresses from the reciprocating parts come at the part of the stroke when those from the steam are the least, that is, at the end of each stroke when steam is being exhausted. There is, therefore, no reason to apprehend any difficulty on this account.

The practicability of allowing a greater amount of reciprocating weight to remain unbalanced in long than in short engines, as suggested in the discussion of last year's report, has been considered. This is being tried by one road—the Great Northern—which reports, thus far, favorable results, although its experience is as yet limited to a small number of engines in service but a few months. A formula for determining the counterbalancing in terms of the length of the engine as well as the weight has been worked out by Mr. H. H. Vaughan, Mechanical Engineer of the Great Northern, and was explained in a paper read before the March meeting of the Northwest Railway Club. This formula disregards the longitudinal vibrations set up by the overbalance, and while doubtless correct for the "nosing" tendency, has been tried too short a time, in our judgment, to receive indorsement. The matter should be thoroughly investigated, however, as the results, it practicable, are decidedly advantageous.

The importance of adjusting the amount of counterbalance accurately is not generally appreciated. The effect upon the track and bridges is proportional to the overweight, and in high speed engines this weight should be as small as the rule adopted permits and not carelessly permitted to exceed this amount. If entire accuracy is not possible, the amount allowed by the rule should be reduced rather than exceeded.

This is especially true for the main wheel, as the rule recommended slightly overbalances this wheel on account of the weight of the back end of the main rod being considered as revolving weight, when in reality it is part revolving and part reciprocating. The error does not exceed 10 per cent. of the weight of the back end of the main rod, and is often much less.

Your committee, therefore, renews its recommendation contained in last year's report, which has been worded differently to correct an ambiguous sentence in the second part of the rule.

RULES FOR COUNTERBALANCING LOCOMOTIVE DRIVING WHEELS.

First. Divide the total weight of the engine by 400; subtract the quotient from the weight of the reciprocating parts on one side, including the front end of the main rod.

Second. Distribute the remainder equally among all driving wheels on one side, adding to it the weight of the revolving parts for each wheel on that side. The sum for each wheel, if placed at a distance from the driving wheel center equal to the length of the crank, or a proportionally less weight if at a greater distance, will be the counterbalance required.

Motors—Steam, Air and Electric.

J. H. McConnell, John Player, W. C. Arp, Wm. Renshaw and V. B. Lang, committee.

Replies were received from 24 railroads and one locomotive builder, reporting 35 steam motors, 162 air motors and 229 electric motors. The Baldwin Locomotive Works reports in service 27 steam motors, 41 air motors and 220 electric motors. Two railroads report nine electric motors in service. Five roads report no air or electric motors in service. In a few instances motors are used with steam and air. Horse-power varies from 2½ to 10 in air motors, and from 10 to 50 in electric motors. Design of air motors both rotary and piston. In steam motors reference is made to stationary engines for driving shafting and isolated machines. Cost of air motors varies from $100 to $150.

Eighteen roads using air motors consider them the most economical and best adapted to the work in shop practice, and at the same time report no experience with electric motors. Air pressure reported shows: One road uses 40 pounds, one 60 pounds, four 70 pounds, one 75 pounds, four 80 pounds, two 90 pounds, four 100 pounds and one 115 pounds.

The committee finds a lack of data as to the relative cost, from a practical standpoint, per horse-power where these machines are used. It also finds the information absent where only one kind of machine is used. This is particularly true of air appliances, presumably on account of the different conditions that would necessarily have to be considered, it being practically in its infancy, as it is only in the last four or five years that it has been recognized as an important factor in all well-regulated shops.

The following are some of the items compressed air is universally used for in connection with suitable appliances, with an average of from 25 to 50 per cent. economy over the former practice:

Tapping out staybolt holes; screwing in staybolts; reaming and drilling holes; chipping and calking; removing tires; beading flues; air hoists, vertical and horizontal, and for all purposes including foundry and ice-house elevators; jacks for raising cars, trucks and locomotives; telescope jacks used in connection with drop pit for dropping drivers; press for forming tinware of every description; presses for general machine shop use and pressing in bushings, driving brasses, etc.; large boiler punches; shears, erected and used outside of shop for the purpose of shearing off test coupons; punching holes that would otherwise necessarily have to be drilled, as the ordinary power punch and shears is not of sufficient gap for the large sheets now going into general use; tank riveters; staybolt nippers and pullers; light stationary air hammers in blacksmith shop, made out of Westinghouse brake cylinders, to be used at tool dresser's fire or where general light work in done; shears at scrap pile for cutting up old bolts to standard lengths, and hammer for straightening; shear for light sheet iron work, made from Westinghouse cylinder at minimum cost; feed for upright nut-tapping machine, allowing operator to handle six taps; also drilling safety holes in staybolts before being screwed in firebox; machine for centering all bolts before turning; Westinghouse cylinders to operate vises without screw, by the operation of air apply couplings to and remove clamps from air hose; also the same appliances for operating a knife to cut off old hose from nipples; sandpapering machine; small Pelton wheel for operating small emery wheels; for sharpening tools in convenient places through the shop; blast for blacksmith forges; Westinghouse engine operating large transfer table; applied to mixing paint in large quantities by putting a pipe in the bottom of a barrel; used in all kinds of motors for boring cylinders and facing valves; grinding steam pipes; driving any

special machine when line shaft is not running; cleaning out flues; in conneetion with gasoline for removing tire; cleaning cushions and carpets in and out of cars; blowing out cylinders before applying packing; testing staybolts; also to move engines to other locations; for different purposes, such as painting, bending pipe, operating letter press, rolling flues, swedging flues, testing brakes, painting cars, sanding roofs, bridges and depots, and several other purposes.

Your committee is decidedly under the impression that both air and electricity are an advantage over steam for portable motors, and also there are conditions existing where the electric power is preferable for large permanent motors via line shaft, for driving large tools, and where a convenient operation of an overhead crane is desired. Leaving the latter out of the question, however, where a line shaft can be conveniently operated with a well-designed stationary plant, your committee is under the impression the latter is the more economical.

For small, portable tools the air motors are no doubt more convenient, if not as economical. As the committee is unable to gather any definite information based upon practical results that would assist us to establish that fact, but considering the danger of electricity which exists to some extent at least, and then considering the convenience of air in and around the shop and the fact that any ordinary mechanic can repair, look after and handle air motors, the relative difference would have to be considerable to make the former preferable; however, the power transmitting capabilities of each in combination with their other individual and peculiar lines of usefulness open for them a distinct and separate field in which neither can be substituted for the other; therefore, it is well to anticipate the possible requirements for other than the transmission of power before coming to a final conclusion.

It seems to be certain that power may be transmitted by compressed air for a considerable distance with less loss than by any other known means. This is not figuring from the moment compression ceases, as there is an inevitable cooling of the air at that time with its necessary loss, but this figure is to be taken after it has assumed its normal temperature, when its loss from any considerable distance is practically nothing.

For general railroad work, with the exception of special cases and conditions as enumerated, a well-designed air plant will be the most convenient and economical, all things considered.

A shop turning out 60 engines per year, with general repairs, has been equipped with an air plant consisting of one compressor, 15-inch steam, 14-inch air and 18-inch stroke cylinders; five ice-house elevators; one hoist for driving wheel lathe; six hoists for lathes and planers; two brotherhood engines; three motors; one pneumatic hammer; one plant for testing air-brakes; one sand elevator; one fire kindler; one flue cleaner.

The cost of the compressor, including foundations and pipe connections, was $1,260.50. Pipe lines, hose, valves, reservoirs, motors, hoists, elevators and other appliances cost $1,189.50. Total, $2,450.

On a test run of eight hours, it required 313 pounds coal per hour, or 2,508 pounds for the eight hours' run.

It required five minutes and 40 seconds to raise pressure from 0 to 120 pounds. Compressor made 538 revolutions and compressed 2,681.6 feet of free air to 193.9 feet at 120 pounds. It requires with this compressor 20.4 pounds coal to compress 1,000 feet free air to 120 pounds, showing 60 per cent. of its theoretical efficiency. As the compressor has been in service 18 months, an overhauling of the cylinder packing and air valves would probably produce a higher efficiency.

Piecework in Locomotive Shops.

P. Leeds, Wm. Swanston, R. P. C. Sanderson, J. G. Neuffer and J. B. Michael, committee.

From the replies to the circular and from the fact that the value of any employee is in direct proportion to the amount and quality of the output resulting from his efforts, it (the piecework system) is, in the opinion of your committee, the most just and equitable method of employing men, as by this means the man who is skilled and industrious reaps the benefit of all the energy and brains expended, and is not put upon a level with one of inferior capacity, or the time server, while both he and his employer receive just what was agreed upon, and if there is a spirit of justice in the setting of prices, there will be no hardship on either side, and these prices should be based upon the average, both as to men and conditions. Even on new work it would be remarkable if there was no variation in the output by the same man, and in repairs, especially where old parts have to be separated, there is a great variation, and in the opinion of the committee the setting of prices should have the same consideration that a competent foreman would give where there are no prices affixed. Such a foreman certainly knows just how long a man should be upon any piece of work, and, failing to obtain proper results, should call the workman to account, and it is in just the extent that a man's pocket is a more inexorable taskmaster under the piecework system than the average foreman, that we may expect better results than would obtain under a competent foreman who had the authority to base the man's pay upon the results of his labor. The averaging of pay has been one of the curses of the daily wage system: there has been no particular incentive for one man to excel another, and it has drifted into an average day's work for an average day's pay. Another thing under the wage system that about offsets the danger of a lack of thoroughness under the piece system is the tendency to expend unnecessary labor on a piece after it is good enough for the service it is intended for. This, in our opinion, accounts for a large percentage saved under the piece system, as it is to the interest of the employee to stop when he gets through. If a man is so thoroughly proficient that he can turn out a great deal more work than any other, and by so doing receives much more wages than his co-laborers, there is no justice in reducing him to the average, even if he is the only one on that particular job in the shop, as the company pays no more per piece than it would pay to another, and, in case of a machine hand, obtains a benefit in the greater output of the machine. If we could increase the output of machinery or shops the 25 per cent. claimed for this system and reduce our plants or increase our facilities that much, that alone would be quite an object, even if we did not get any benefit in the ultimate cost of the labor. This certainly would mean 25 per cent. less time for equipment in shops and a saving all around, and as, so far as the committee is informed, this question is "with but few exceptions," most heartily indorsed by those who have tried it most extensively, the committee considers that its investigation warrants it in most heartily recommending its adoption, and this is fully in accordance with the experience of those members of the committee who have had considerable to do with piecework.

Boiler Jackets.

T. B. Purves Jr., C. G. Turner, E. L. Coster, A. E. Mitchell and J. E. Sague, committee.

The replies [to the question: "How often do you find it necessary to paint steel or sheet iron jackets?"] received from American railways vary between twice a year and once in two and one-half years, but the majority of the replies recommend that jackets be painted every six months.

The Manchester, Sheffield & Lincolnshire Railway paints its jackets about every three years, while the Ferro-Carril Gran Oeste Argentina Railway paints sheet iron jackets every year.

The Norfolk & Western Railway is of the opinion that a planished iron jacket painted over is not so durable as a sheet iron or steel jacket painted; and the Northern Pacific Railway believes that sheet iron jackets should be painted twice as often as those of sheet steel.

The Toledo, Ann Arbor & North Michigan Railroad paints planished iron jackets every 15 or 18 months, and the Delaware, Lackawanna & Western Railroad paints its jackets whenever the gloss begins to wear off, or they show signs of rust.

Some roads paint sheet iron and steel jackets whenever a new jacket is applied, or an old one replaced; or whenever locomotives are painted; or are in the shop for general repairs, say once every 50,000 or 100,000 miles.

It is the almost universal opinion that it is necessary to paint the inside of all jackets prior to application, in order to prolong their life by preserving them from internal rusting and corrosion. This painting is particularly desirable when fresh wood lagging is used, as the aciduous moisture arising from the sweating or streaming of the latter will, especially when the engine is cold, adhere to the jacket surface, and cause quite rapid corrosion of the latter.

The Northern Pacific Railway reports that this corrosive action is more noticeable with sheet iron than with either steel or planished iron jackets; and the Norfolk & Western Railway states that the internal oxidation of unpainted jackets is especially rapid when asbestos cement boiler coverings are employed.

The Chicago, Rock Island & Pacific Railway states that leaking boiler seams are the jacket's worst enemy, although the sweating of the boiler may at times cause moisture to condense on the inside of the jacket and produce oxidation of the latter, if unprotected by paint.

The Baldwin Locomotive Works replies that according to its experience the wearing out of jackets is usually due to the general carelessness of employees in charge of the management and repair of locomotives, no care being taken to prevent jackets from rusting, or from being walked over and hammered out of shape. This is especially the case where wood lagging is used, and has become charred or burned off.

The Chicago & Northwestern Railway states that if the jackets are painted inside when new, and again whenever they are removed, there is practically no internal corrosion; consequently the wear is from external abrasion.

The Union Pacific Railway states that jackets wear out from external abraison, and from corrosion due to acid drippings from the roundhouse roof.

The average of the mean life given in the different replies is 10.57 years, the minimum and maximum life mentioned being 2 years and 12 years.

The Delaware, Lackawanna & Western Railroad reports that it has Russia iron jackets which have been more than 20 years in service, the jackets being now painted.

It is the prevailing opinion that properly painted sheet iron and steel jackets are *less* seriously affected by the acid-laden moisture than are planished jackets, on account of the protection afforded to the former by the paint.

It is claimed by several master mechanics that when a leak occurs in the boiler, the wood lagging permits the steam to spread all under the jacket, while the magnesia and asbestos coverings tend both to confine and absorb the issuing steam and water. The jacket is also far better supported by the latter coverings than by the former; it is therefore less liable to be dented or otherwise mechanically injured, and the possibility of the lagging taking fire is eliminated.

From a careful consideration of the foregoing your committee concludes that it is more economical to use boiler jackets of common sheet iron, or sheet steel painted, than it is to use jackets of planished iron.

Abstracts of the remaining reports will be printed in the next issue.

AMERICAN ENGINEER
CAR BUILDER AND RAILROAD JOURNAL.

AUGUST, 1897.

CONTENTS.

The Lighting of Isolated Railroad Stations.

The principal disadvantages of separate lamps with glass reservoirs for the lighting of stations are the amount of labor they require in filling and cleaning, their small illuminating power and the liability of disastrous fires resulting from accidental breakage. Even with oil of a high flash-point the danger of conflagration is not entirely avoided. Such small flat-flame lamps usually burn about 0.01 gallons of oil per hour, corresponding to a candle-power of about seven, and an expenditure of 0.06 cents for oil. Now, as the candle-power of ordinary flat-flame gas burners is from 10 to 20, we see that such stations are comparatively poorly lighted by the small lamps. The labor involved is considerable, as the lamps must be filled every alternate day, the wick trimmed and globe cleaned, which consumes nearly half a day in stations using over 30 lamps.

Gasoline plants are expensive to run and liable to explosion when not properly handled. Gas and electricity are not to be considered for isolated stations, as small plants are so very expensive as to be out of the question from economical considerations alone, and as a result railways have been employing separate lamps at their country stations almost exclusively.

While passing along the line of the New York, New Haven & Hartford Railroad, a system was noticed which seemed new, and through the courtesy of Mr. Wilson, Chief Train Dispatcher, we are able to present some figures of interest to railroad men on a connected-lamp system of oil-lighting. Although this system has been known for probably 15 years, it is not more than four years ago that it received its first application on railroads, and as far as the writer can determine, this road is the only one using such a system at the present time.

The types which have been put on the market may be classified as follows:

I. Reservoir on a level with the lamps.
 a. Underneath system of piping.
 b. Overhead or siphon system of piping.
  1. With siphon air collector.
  2. With pump siphon renewer.
II. Reservoir placed above the lamps.
 a. Flow of oil regulated by valve and float.
 b. " " " " " mercury and float.

A brief review of this classification will lead to a better appreciation of the system in general. The first system is shown in diagram in Fig. 1. The reservoirs are made of galvanized iron, which are carefully soldered and very rarely leak. Reservoir *A* is filled, while inverted, through the opening made by removing the pipe *D*, and is again replaced as shown. *B* is a stationary reservoir having a constant level of oil which enters through *D*, escapes to the lamps through *H* or overflows by *B* into *C*. The top of the oil is about two inches below the level of the top of the wick—all lamps being on the same level. When the level of oil in *B* falls below the end of *D* it permits air to enter *A* through *D* and allows an equivalent quantity of oil to flow out. This automatic arrangement works very well. In underneath piping, the pipes *H* run down to and under the floor and up the sides of the room or post; here there is pressure in the pipes and leakage may occur.

In running the pipes overhead by the siphon system the air tends to enter any orifice in the pipes instead of the oil flowing out, so that there is no trouble from oozing oil. All air tending to break the continuity of flow collects in the highest point of a siphon, and a small reservoir is placed here to catch the air. When nearly filled with air the globe *G* is inverted, which shuts

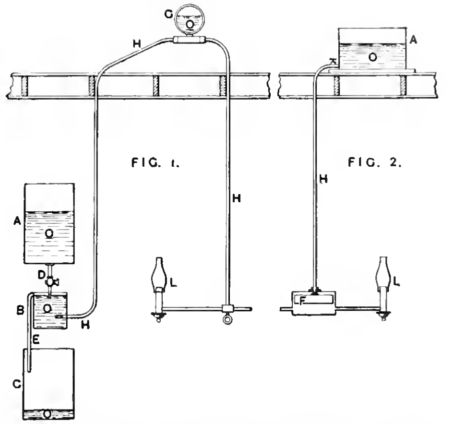


FIG. 1. FIG. 2.

A, Supply reservoir; *B*, Feed reservoir; *C*, Overflow tank; *D*, Supply nozzle; *E*, Overflow pipe; *F*, Admission float; *G*, Glass bulb air collector; *H*, Oil pipe; *L*, Lamps.

off both branches, the globe screwed off, filled with oil, replaced and returned to position as shown. This must be done once a week.

Another lamp re-establishes a siphon by having parallel pipes, and when the flow ceases, a small plunger pump situated in *B* forces oil through one pipe and back through the other, carrying the troublesome air along with it. The pipe *H* ends at the foot of the chandelier in a spring cone valve. When the chandelier is in position for burning, the stem of this valve is pushed up by the bottom of the T connection, allowing the oil to flow freely; when the chandelier is pulled down, a spring seats the valve and stops the flow of oil. This oil pipe runs inside the chandelier stem and packing is placed between the two. Argand burner lamps with 5-inch circumference wicks complete the outfit. These lamps are usually provided with central draft and have their wicks raised by several methods in common use; drip cups are necessary with all forms. For outside use the underneath system may be employed, as it does away with any attention required by the siphon, although the other is preferable where the possible stains or odor of oil would be objectionable. This system is cleanly and is so much liked that a score of stations on the New Haven road have it in daily operation.

When the reservoir is placed above the lamps, the lamps can be placed on any level below it, which is of considerable advantage, although not a necessity in station lighting. In the previously mentioned class separate reservoirs were necessary for each level, of which there are three, in the case of the outfit at Riverside. When oil is placed under pressure, however, it is difficult to con-

fine it and this is the trouble with this class of distribution. Each lamp or cluster of lamps has its individual reservoir, which contains a float operating a valve, seal, or other device to close the oil supply pipe when this small reservoir is filled to the required height. In Fig. 4 will be seen a device by which the float *F* forces a mask of a certain composition against the end of the fixed supply pipe. This is in use at Greenwich and Stratford stations, and although they furnish a satisfactory light there is sufficient dripping to cause annoyance, and the lamps sometimes are fed too strongly by imperfect action of the valve, causing smoke and excessive consumption of oil. This device is replaced by another firm by a conical valve on a triple seat which is pushed up when the float falls. Such mechanical devices are not satisfactory in general.

Another device, Fig. 6, in the form of a mercury seal is in operation in this country and, as shown in Fig. 5, in England. In both cases as the float *F* falls the head of mercury *H* outside the oil feed pipe *C* falls also. If this head of mercury is so adjusted as to exactly balance the head of the oil from the reservoir above, the oil will flow out of the end of the pipe as soon as the head of mercury becomes less, and will cease flowing when the original level is attained. This valve works well and gives satisfaction, according to the statements of those who use it. The same remarks on oil under pressure hold good here also, and the system is slightly defective, especially as the head above the lamps is not constant while the reservoir is becoming empty.

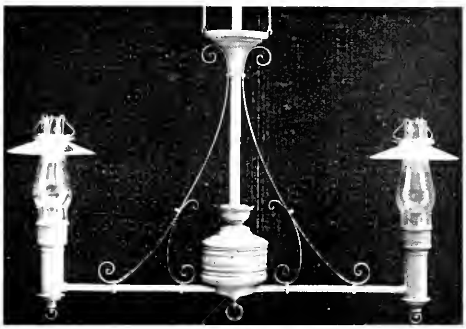


Fig. 3.—Plain Oil Lamp Chandelier.

The class first described has given the best satisfaction, not only in small stations but in more pretentious ones, as at Meriden, where 38 lamps are used, where the price of gas is $1.80 per 1,000 feet, and the railroad preferred to use oil to being imposed upon. At the time the lamps were put in gas was selling at not far from $2.50 per 1,000 cubic feet, and the electric light company controlled both gas and electric lighting. As the consumption of oil at this station is but about 50 barrels per year the siege will probably last some time into the future.

Mr. Julien Lefevre stated before the French Association for the Advancement of Science that 30 grams of kerosene oil were burned per *carcel-heure*, which is equivalent to 0.00135 gallons per candle-power. Professor Jacobus before the Franklin Institute said that his experiments indicated that a 16 candle-power lamp would consume 0.022 gallons of oil per hour, equivalent to 0.00137 gallons per candle per hour. These figures from widely differing sources agree very well, and one could with safety assume the mean, 0.00136, as the basis for calculation. Assume that 0.25 cubic feet of illuminating gas are consumed per candle-power per hour; take the price of gas in small towns at $1.75 per thousand feet, the cost of oil at 8 cents per gallon and incandescent electric light at one cent per hour per 16 candle-power; then we have the following comparison of three methods of lighting stations:

One candle power from	Consumption per hour.	Cost per hour, cent.
Incandescent electric lamps	0.006 horse-power	0.0625
Illuminating gas	0.25 cubic foot	0.04375
Kerosene oil	0.00136 gallon	0.01088

The item of cost must be settled by local conditions. At Wallingford station the oil lighting system displaced gas. The candle-power claimed for these lamps is about 38, corresponding to a consumption of 38 × 0.00136 = 0.05168 gallons per lamp hour. The actual quantity of oil burned per lamp hour is difficult to secure as no detail records are kept. Meriden uses 5 to 6 barrels (52 gallons each) in midwinter and three barrels in midsummer; there are 38 lamps, in use of which 11 are outside. Making an approximate calculation of hours burning, the consumption of these lamps is 0.02 gallons per lamp hour.

At Riverside station two barrels of oil are used per month. Of this about 30 gallons are used on switch and tower lights, 16 gallons are burned in seven separate flat-wick glass reservoir lamps

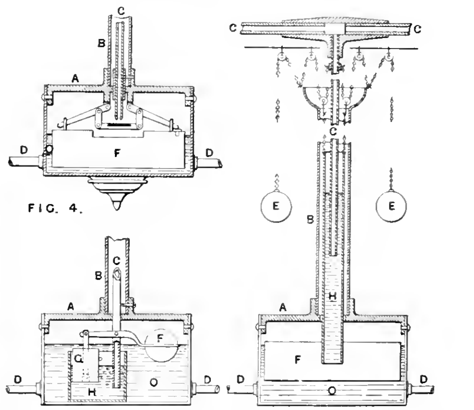


FIG. 4. FIG. 5. FIG. 6.

A, Small reservoir; *B*, Stem of chandelier; *C*, Oil pipe; *D*, Pipe to burners; *E*, Counter weights; *F*, Air-tight floats; *G*, Hollow plunger; *H*, Mercury; *O*, Oil.

(0.01 gallon per lamp hour). Three outside and five inside argand lamps are in constant use, although there is a total of 17 of these lamps at the station, some of which are lit but part of the time. The argand burners connected in the over-head siphon system, consume 58 gallons of oil per month. A close calculation shows that this is equivalent to 0.03 gallons per lamp hour. A store using six lamps reported a consumption which indicated 0.038 gallons per lamp hour used. The manufacturer claims a consumption of 0.042 gallons, corresponding to about 31 candle-power, although he claims 38 candle-power. Another make of lamp at Greenwich consumes relatively one-fifth more oil than those at Riverside station, partly by reason of the reservoir being at a higher level, and also on account of a greater candle-power. Such are the results from practice, which indicate that the candle-power lies between 20 and 30, much greater than any single gas burner usually employed.

The following is the relative consumption and cost of lighting of several stations with oil and gas:

Gas jets.	Number of burners.	Monthly average for the year 1896. Cubic feet.	Gas bill.
Pelham	20	7,100	$10.65
Mamaroneck	11	6,200	10.85
Rye	7	5,200	9.10
Oil argand lamps.	**Number of lamps**	**Approximate monthly average for year 1896. Barrels.**	**Oil bill.**
Meriden	38	4.5	$18.00
Greenwich	31	4.5	18.00
Riverside	17	1.5	6.00

Even if we assume that the gas jet would give an illumination equivalent to an argand oil lamp and that the same proportion of illumination hours would hold for each lamp and jet, yet the cost of oil compared with that of gas would be in the ratio of 50 to 80 cents per light per month.

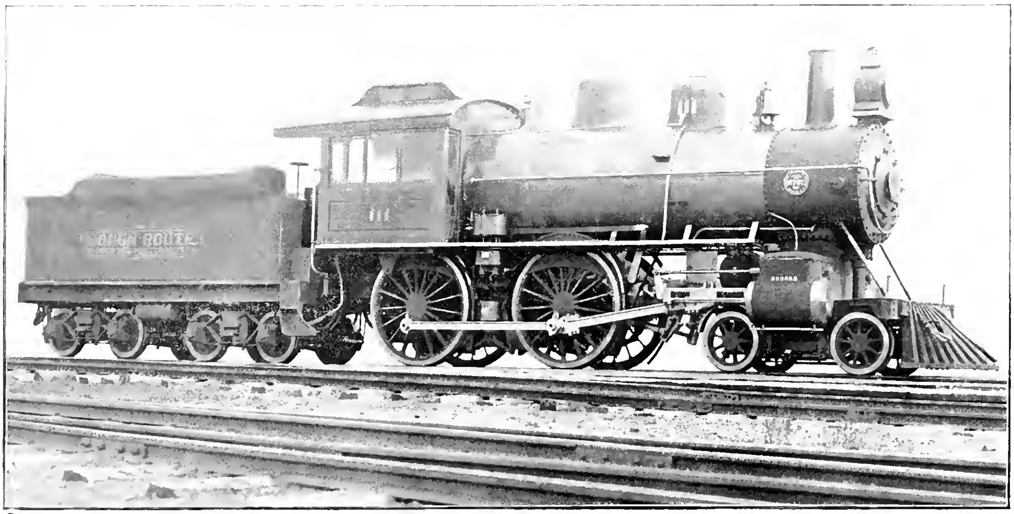
Eight-Wheel Passenger Locomotive—Chicago, Indianapolis & Louisville Railway.

The Chicago, Indianapolis & Louisville Railway, the Monon route, has recently received an eight-wheel passenger locomotive from the Brooks Locomotive Works, the general appearance of which is shown in the accompanying engraving. The more important dimensions of the parts and details of the design are given in the accompanying table, a few of which merit special mention.

The weight on driving wheels is 79,000 pounds, the total weight of the engine being 121,800 pounds and in view of these figures the heating surface is seen to be large, viz. 1,950 square feet. The grate area is 26.8 square feet, which gives a ratio of 72.7 to 1 between the heating surface and grate area. This ratio compares very closely to that of the "Big Four" passenger locomotive of the same type which was illustrated in our issue of January, 1896. The latter has 2,175 square feet of heating surface and 30.75 square feet of grate area, a ratio of 70.07 to 1, but these ratios appear small when contrasted with that of the 10-wheeled compounds of the Northern Pacific, shown in our June number of the current volume, which is 81 to 1. The heating surface of the design under review is large for an eight-wheel engine and gives a further indication of the tendency toward increasing the heating surface to the largest limit possible.

In the construction of the boiler the fewest possible number of sheets have been used, the taper sheet being the first course back of the smoke arch, and which brings the number of courses down to three. The wagon-top is large with this arrangement, and the amount of care given to the boiler seams must be materially reduced. The crown sheet is held by radial stays, no swinging stays being used at the front end. The fire-box slopes downward toward the front, and is placed over the frames, the support for the back end of the boiler being in the form of expansion pads, so arranged as to carry some of the weight to the lower bars of the frames. The whistle and pops are carried on a small dome immediately in front of the cab.

Among the other features of interest in the design are hollow crank pins, brakes upon the truck wheels, arched steam chest covers, light crossheads of the four-bar type, I-beam equalizers hung below the frames and connected to underhung driving springs, and a generally clean appearance of the boiler due to placing the check valves inside the cab. We hope to present some of the details of the locomotive in a future issue. The special attachments and their makers are given in the list appended to the following table of dimensions:



Eight-Wheel Passenger Locomotive—Chicago, Indianapolis & Louisville Railway.
Built by the Brooks Locomotive Works, Dunkirk, N. Y.

GENERAL.

Gauge	4 feet 8½ inches
Kind of fuel to be used	Bituminous coal
Weight on drivers	79,000 pounds
" " truck wheels	42 800 pounds
" total	121,800 pounds
" tender loaded	88,000 pounds
Wheel base, total, of engine	23 feet 5 inches
" " driving	8 feet 6 inches
" " total (engine and tender)	48 feet 6 inches
Length over all, engine	31 feet 8½ inches
" " " total, engine and tender	58 feet 1½ inches
Height, centre of boiler above rails	8 feet 7½ inches
" of stack above rails	11 feet 11½ inches
Heating surface, firebox	145.6 square feet
" " tubes	1,804.4 square feet
" " total	1 950 square feet
Grate area	26.8 square feet

WHEELS AND JOURNALS.

Drivers, number	Four
" diameter	72 inches
" material of centers	Cast steel
Truck wheels, diameter	33¼ inches
Journals, driving axle, size	8½ by 11 inches
" truck " "	5½ by 12 inches
Main crank pin, size	6 by 5½ inches

CYLINDERS

Cylinders	18 by 26 inches
Piston rod, diameter	3½ inches
Main rod, length center to center	7 feet 10 inches
Steam ports, length	17 inches
" " width	1¾ inches
Exhaust ports, length	17 inches
" " width	3 inches
Bridge, width	1¾ inches

VALVES.

Valves, kind of	Richardson, balanced
" greatest travel	7 inches
" outside lap	1⅛ "
" inside lap or clearance	0 "
" lead in full gear	0 "

BOILER.

Boiler, type of	Wagon top
" steam pressure	190 pounds
" thickness of material in barrel	⅝ and $\frac{11}{16}$ inch
" diameter of barrel	62 inches
Seams, kind of horizontal	Quintuple riveted
" " circumferential	Double "
Thickness of tube sheets	⅝ inch
" " crown sheets	⅜ "
Crown sheet stayed with	Radial stays
Dome, diameter	30 inches

FIREBOX.

Firebox length	8 feet 1 inch
" width	3 feet 5 inches
" depth front	79 inches
" " back	62 inches
" thickness of sheets	⅜, $\frac{5}{16}$ and ⅝ inch
" brick arch?	Yes
" water space, width	Front, 4 inches; sides, 4 inches; back, 4 inches
Grate, kind of	Cast-iron rocking

TUBES.

Tubes, number	300
" material	Charcoal iron
" outside diameter	2 inches
" length over sheets	11 feet 7½ inches

SMOKEBOX.

Smokebox, diameter	65 inches
" length	58 inches

TENDER.

Tank capacity for water	4,000 gallons
Coal capacity	8 tons
Thickness of tank sheets	3/16, 1/4 and 5/16 inch
Type of underframe	Wood
Type of truck	Diamond
Truck	With rigid bolster
Type of truck springs	Double elliptic
Diameter of truck wheels	33
Diameter and length of axle journals	4¼ by 8
Distance between centers of journals	5 feet 0 inches
Diameter of wheel fit on axle	5⅜ inches
Type of truck bolster	I beam
Length of tank	19 feet 6 inches
Width of tank	8 feet 8 inches
Height of tank over collar	67 inches

SPECIALTIES.

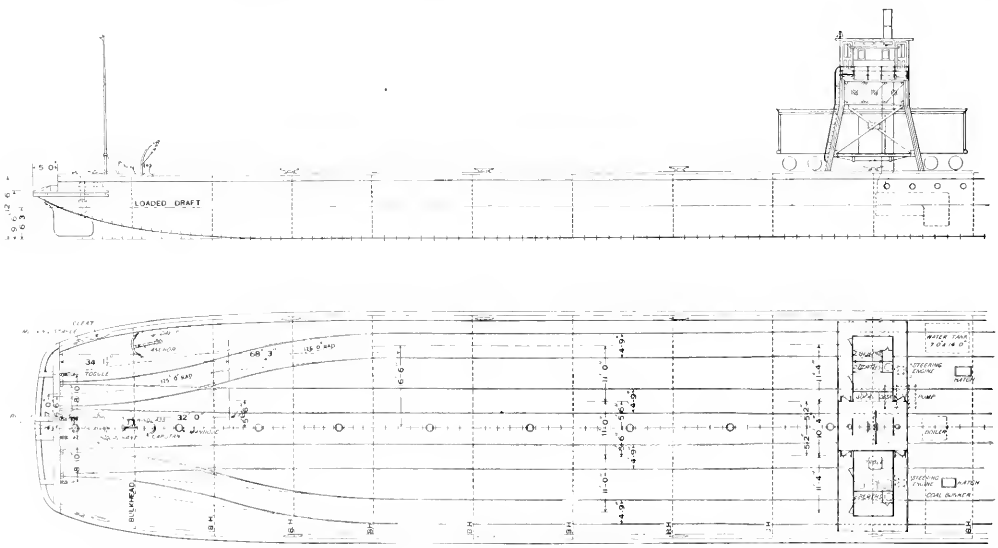
Wheel centres	Pratt & Letchworth
Tires	Midvale
Axles	Cambria Iron and Steel Company
Sight feed lubricators	Nathan Manufacturing Company
Bell ringer	Gollmar
Safety valves	Consolidated Safety Valve Company
Injectors	"Metropolitan" Hayden & Derby Manufacturing Company
Driver brake equipment	New York Air Brake Company
Tender brake equipment	New York Air Brake Company
Tender brake beams	Sterlingworth Railway Supply Company
Tender brake shoe	Brooks Locomotive Works
Air pump	No. 2 New York Air Brake Company
Steam gages	Ashcroft Manufacturing Company
Engine truck, driving and tender springs	A. French Spring Company

Car Float—New York, Philadelphia & Norfolk Railroad.

A large car float is being built by the Crescent Shipbuilding Company at Elizabethport, N. J., for the New York, Philadelphia & Norfolk Railroad, and through the courtesy of Mr. Theo. N. Ely, Chief of Motive Power of the Pennsylvania Railroad, we are enabled to illustrate and describe it. The float is to be one of the largest ever built and will be known as barge No. 5. It is to be used for the transfer of freight cars between Cape Charles and Norfolk, Va. The length is 340 feet, the beam over all is 47 feet 3 inches, verse steel bulkheads spaced 20 feet apart. A 6-inch pipe, which runs the entire length of the float, is provided with valves in each compartment for trimming the float with water ballast. The amidship compartment contains the boiler, pumps and steering engines.

The float is being built to drawings prepared by the railroad company and the details have been admirably worked out. The boat has no shear and the deck plating is flush, the seams being made on joint plates upon the under side. The bottom plating is of the usual form with out and in strakes. The keel plate is 7/16 inch thick and is 6 feet wide, being straight. The plates in transverse section are straight from the keel plate to the bilge, where they turn on a radius of 4 feet, and the sides from there to the deck are vertical, which is not an unusual construction. The bottom plates on both sides of the keel plate are ⅜ inch thick, and 5/16-inch plates are used for the deck. The frames are placed 2 feet 6 inches apart at the center and 2 feet at the ends of the boat. They are of angles 4 by 3 inches of 8½ pounds section. The deck beams are also of the same sized angles and they are gusseted to the frames and to the longitudinal bracing. This longitudinal bracing consists of six trusses which run the entire length of the boat and are virtually keelsons extending from the bottom plating to the deck. The chords of the trusses are 15-pound plates, 18 inches wide, and the bracing between them is made of 4 by 3 inch 8½-pound angles. The verticals or struts are T-sections, 4 by 4 inches of 8½ pounds section. The struts are omitted at the bulkheads and two 4 by 3 inch angles with the 5/16-inch bulkhead plate between them are substituted therefor. The bulkhead plates are joined to the bottom plating by 3 by 3 inch double angles and gusset plates are used in the deck connections. The truss plates are continuous and gussets are used at each frame. The keel plate is braced by vertical transverse plates to which the frames are riveted.

The deckhouse is carried on a large bridge supported by four posts of channels which have ample gusset bracing at the deck and bridge. In the deckhouse are the pilot-house and cabins for



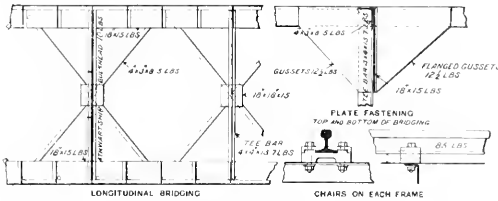
Car Float, New York, Philadelphia & Norfolk Railroad—Crescent Shipbuilding Company, Builders.

beam over hull 45 feet 4 inches and the total depth 12 feet 6 inches. The draft when light will be 3 feet 3 inches and when loaded 6 feet 3 inches. There are four tracks, which will hold 28 cars, and the equipment and appointments of the boat will be complete and well arranged.

The hull is divided into 18 water-tight compartments by trans-

the crew. The float has two rudders, one at each end, which may be worked by two independent Williamson steam steerers or by independent hand gear. The rudders are made on spider frames and have no bottom support. All of the machinery is located in the compartment under the bridge. Steam is supplied by a small Scotch boiler 5 feet 6 inches in diameter by 7 feet long,

and 3,500 gallons of fresh water may be carried in a cylindrical tank in this compartment. The pump for trimming the float and for fire purposes is of the Snow duplex pattern, with $8\frac{1}{2}$ by 10 inch cylinders. The 6-inch pipe already referred to connects this pump with all of the compartments, and communication either for emptying or filling them may be made by a valve controlled by a hand-wheel at the deck over each compartment. A



Car Float—Longitudinal Bracing.

Providence brake windlass and a Providence hand-power capstan are provided at each end of the float.

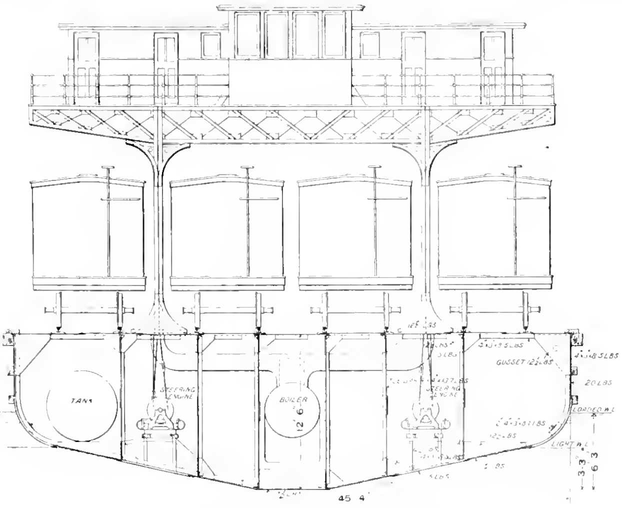
The courtesy of Mr. Lewis Nixon, of the Crescent Shipbuilding Company, and of Mr. Theo. N. Ely and Mr. H. S. Hayward, of the Pennsylvania Railroad, are acknowledged.

Heating Apparatus, Belgian Grand Central Railway.*

BY E. BELLEROCHE.

In the Minutes of the Proceedings of the St. Petersburg Meeting of the International Railway Congress there is a description of the system of heating passenger trains which was examined and adopted by the Belgian Grand Central Railway.

It will be remembered that the system consists essentially of circulating hot water along the train and back again, starting from and returning to the engine.



Car Float—Transverse Section.

The circuit consists of two parallel pipes all along the train which are fixed in the floors of the carriages, one being for the flow, and the other for the return; they are connected on the last carriage by a tail pipe which turns the current back into the return pipe.

A range of radiators is connected centrally and perpendicularly to each of the pipes, and lies in the same plane as the pipes.

Each carriage therefore contains two sets of radiators supplied one by the outward pipe and the other by the return pipe.

In this way, a uniform temperature of the heating surfaces in all the carriages is obtained from end to end of the train, the temperature being equal to the mean of the temperatures of the radiators.

The current of water taken from the tender is heated, and caused to circulate either by a small donkey pump and a jet of steam, which heats the outflowing water to any desired temperature, or else by means of a special injector, the temperature of the outflowing water being raised if necessary by means of a steam jet.

The engine driver also controls the temperature in the train by the indications of thermometers placed at each end of the circuit. He regulates the speed of the flow by the indications of a pressure gage. He can thus always regulate the amount of heat sent into the train according to circumstances.

This arrangement puts in the driver's hands the power of controlling between the widest possible limits the amount of heat sent out, and of proportioning it to the number of carriages, and to the external temperature, by regulating the delivery of the pump, and the amount of steam, which determines the temperature of the outflowing water.

It makes the boiler feed independent of the train heating, and the train heating independent of the caprices of injectors.

It was on account of secondary considerations that this plan was not adopted.

The locomotive appliances which have been fitted to most of the engines on the Belgian Grand Central Railway consist essentially of a special heating injector, the starting point of the outflowing current which is fed with cold water from the tender. The water after passing round the train is collected in a special reservoir in the tender, the end of the return circuit, and this water, which has a temperature of 50 degrees to 65 degrees C., is used to feed the boiler.

The delivery of a No. 5 injector is sufficient to heat a train of the maximum length in regular use. One of the feed injectors is connected to the outflow pipe to help to start the heating.

The apparatus to which we refer, though simplified, is still too complicated to apply to existing stock.

This combination gives the driver the following means for regulating the amount of heat sent out: the variation of the steam jet which heats the water as it comes from the heating injector; the stopping of the heating injector and the use, as arranged, of the feed injector.

It necessitates the use of pumps for feeding the boiler, or else of special injectors adapted for high temperatures, which means that the existing injectors must be taken out.

This method was abandoned on account of its complication and the failure of all the experimental arrangements made since the beginning of our trials, in order to try the following system.

The water after passing round the train is delivered straight to the heating injector, which thus connects together the two ends of the heating circuit. The total supply of water to this injector consists of two parts:

1. The quantity of water required for heating the train and furnished by the return current. This quantity is again sent out to the train;

2. A quantity supplied from the tender, sufficient to lower the temperature of the mixture to an extent determined by the necessities of the heating. This quantity is delivered to the boiler.

The use of a No. 7 injector insures sufficient heating powers for the largest trains in the coldest weather.

The return current to the tender is subject to variations of speed caused by the presence of air remaining imprisoned in the pipes, and also by the impulses due to the inertia of the water when the train is stopping and starting; owing to these irregularities it is wise to use a restarting type of injector for the heating injector.

The apparatus by which we solved the problem this winter is extremely simple.

The heating injector is fitted with a branch which turns the balance of the supply, not used for heating, into the boiler.

The mixture takes place before they reach the injector at the point where the cold water from the tender enters the circuit; an intimate mixture is insured by the division of the current of hot water into fine jets by means of the small holes in the end of the pipe

* From a paper published in the Bulletin of the International Railway Congress.

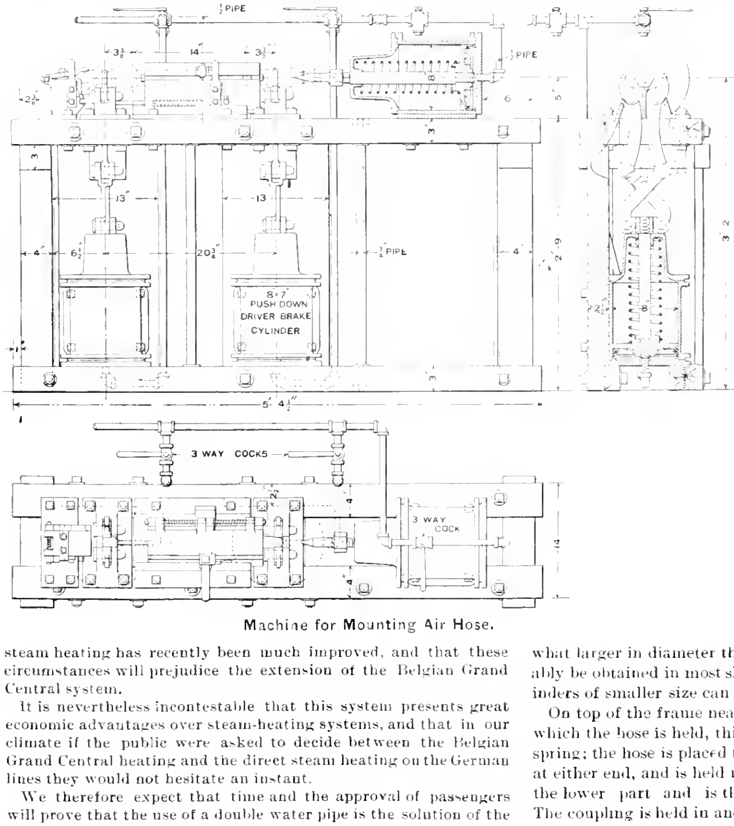
through which it flows; these jets strike against vanes arranged in a ring, which are in constant vibration owing to being suspended on the end of a spring.

This apparatus is completed as in the former arrangement by a connection on the delivery pipe of the injector to one of the boiler-feed injectors which is used as a help at starting.

The driver can regulate the amount of heat sent out by the following means: By varying the amount of water delivered to the train, by varying the amount of steam used in the extra steam jet which further heats the water after leaving the injector, or by shutting off this jet altogether.

This system requires that the boiler should be fed continuously; the gradients on the line and the shortness of the train may require the heating injector to be stopped for short intervals, which means that the heating is also stopped. These difficulties confuse the drivers at first, but they get used to them.

There is no doubt that the tendency of modern ideas on the heating of trains is toward the use of a single steam pipe, and that



Machine for Mounting Air Hose.

steam heating has recently been much improved, and that these circumstances will prejudice the extension of the Belgian Grand Central system.

It is nevertheless incontestable that this system presents great economic advantages over steam-heating systems, and that in our climate if the public were asked to decide between the Belgian Grand Central heating and the direct steam heating on the German lines they would not hesitate an instant.

We therefore expect that time and the approval of passengers will prove that the use of a double water pipe is the solution of the question of train heating in our climate.

Practice has already proved the apparatus. The only improvements which we think ought to be made in new applications are to decrease the diameter of the pipes, and to increase the size of the emptying cocks, and to modify the coupling of the flexible pipes which connect the carriages.

The Belgian Grand Central radiators can be connected so as to work full or empty as appartus for steam heating, in international trains, by connecting them with the steam pipe of the latter.

At the same time the present tendency is to use carriages of special types for the international traffic.

The only serious trouble in the Belgian Grand Central system is the emptying—a question of organization.

No system, continuous or not, is free from such difficulties. Steam heating has also its continuous drains, and we have more confidence in the employment of responsible agents than in the action of automatic apparatus.

Machine for Mounting Air-Hose.

BY OSCAR ANTZ.

The extensive introduction of air-brakes on freight cars has made the maintenance of the hose connection a matter of considerable importance. When a hose is removed from a car on account of being unsafe, or perhaps burst, the coupling and nipple are usually found to be good for use again, and it is the custom of most roads to-day to buy new hose in proper lengths and put in the couplings and nipples, either new or second-hand, in their own shops. This mounting of the hose is sometimes done entirely by hand, the fittings being forced into the hose and the clamps screwed up without the use of any machinery. This has, however, been found to be too slow a process, and machines of more or less elaborate design have been devised for doing the work, nearly all of which make use of compressed air for the necessary power. Most of the machines of this kind which have been described in the technical papers require several changes of the position of the hose from one place to another before the work is complete, which entails considerable loss of time, and it was for the purpose of doing all the operations without changing the position of the hose that the machine herewith illustrated was designed. Similar machines have been in use in a number of shops for several years, and the pieces of hose are mounted by two workmen, complete and ready for testing, in about half a minute for each hose.

The machine, of which the drawings show the general arrangement, consists of a framework of wood, strongly bolted together, on which are fastened three cylinders, the pistons of which are operated by compressed air, one for forcing the fittings into the hose and the other two for putting on the clamps. The cylinders shown are the regular Westinghouse 8 by 7 inch push down driver brake cylinders as employed on locomotives. These are usually kept on hand in railroad shops; they are perhaps somewhat larger in diameter than is necessary, but as they can probably be obtained in most shops much more readily than new cylinders of smaller size can be made, they are shown here.

On top of the frame near the center, is located a sliding vise in which the hose is held, this vise being forced to the right by a spring; the hose is placed in this vise with equal parts projecting at either end, and is held in place by the cover which is hinged to the lower part and is thrown back by springs when released. The coupling is held in another vise, placed on the left end of the frame and is made so as to hold either one of the three styles of hose couplings which are at present in use. The couplings are held in such a way that the part which enters the hose is horizontal. The cylinder is placed on the right end of the frame, and the piston rod is provided, instead of a cross-head, with a nut having a round end over which the nipple is placed.

To mount a hose, the coupling, nipple and a piece of hose are placed in the machine as stated and as shown by dotted lines, and a small amount of thin rubber cement is smeared on the parts which enter the hose and also on the inside of the ends of the hose. When pressure is applied in the cylinder, the piston forces the nipple into the hose and the latter being free to slide with the vise in which it is held, forces itself over the end of the coupling. When mounted, the covers of the two vises are released and the hose can be moved slightly if necessary to bring it in the

right position for putting on the clamps. This slight adjustment is found necessary sometimes on account of variations in the lengths of the different pieces of hose. The apparatus for putting on the hose clamps consists for each end of the hose of a vertical cylinder, to the cross-head of which are attached a combination of four levers, arranged in such a way that with an upward motion of the piston the upper ends of the upper levers are forced toward each other in almost a horizontal direction. The lugs on the back of the hose clamp are placed against the steel points of these ends and on the application of pressure, the clamps, which are placed on the hose before the fittings are put in, are forced around the hose, bringing the lugs for the bolts close together, when the latter can be put in and the nuts screwed up with but little help of a wrench.

The principal parts of this machine are shown in detail and do not require any further explanation. The pins used in the connections of the clamping device are the M. C. B. standard air-brake pins and the three-way cocks can be made of the regular half-inch Westinghouse cut-out cocks by filling in where necessary with babbitt or solder, although better results are obtained by making new castings for the chamber and plug.

The "Compo" Brake Shoe.

The exhibit of brake shoes by the Composite Brake Shoe Company, at the recent Master Mechanics' and Master Car Builder's conventions attracted considerable attention and comment. The shoes were shown in various stages of wear from new unworn shoes to those which had seen 20,000 miles of service. The principal object of this shoe is to introduce into that section of a brake shoe which comes in contact with the wheel where the rails wears it, a softer material that will have a high braking efficiency, and still not wear away the wheel. This type of brake shoes is of special interest because of the employment of sections of cork which are secured in recesses in the face of the shoes by means of dovetailing assisted by compression of the corks. When heated by the friction of the shoes upon the wheels, the corks have a tendency to expand, which assists further in holding them firmly in position. This is not the first application of wood in this connection, as will be seen by an examination of the report of the 1895 convention of the Master Car Builders' Association, but in the earlier experiments the wood gave trouble from shrinking and loosening in the shoes, though the friction obtained was high.

This difficulty appears to have been entirely overcome by the use of cork, and increased frictional qualities are obtained without the shrinking and loosening. It is stated that the experience with these shoes has shown no case of the corks working loose, that the tire-dressing properties of the shoes are excellent and that there is no tendency to cut or groove the tires. A claim that is strongly urged for the cork shoe is that the elasticity of the plugs acts in such a way as to avoid the gripping and setting of shoes, which tends to lock the wheels and cause sliding. The manufacturer aims to produce a brake shoe with the retarding features of soft cast iron and with the wearing qualities of hard cast iron. Furthermore, they say if shoes can be used that are composed partly of chilled and partly of soft iron, shoes having cork inserts can be made wholly of chilled iron which will give a maximum of braking and mileage results with a minimum of wear on the wheel.

The exhibit referred to consisted of six shoes which had seen service and two new ones never used. One of the worn shoes ran 57 days on a locomotive driving-wheel and made 11,970 miles between Aug. 8 and Oct. 3, 1896, with 100 service stops per day. The corks and the face of the shoe were both in excellent condition, the shoe being only partially worn out. Another driving wheel shoe had been used 50 days and made 10,500 miles. A similar shoe to that first mentioned had made 20,160 miles, and a tender shoe which had made 6,268 miles and 5,382 stops appeared to be good for a large additional amount of service. The remaining example was a driving-wheel shoe, the corks of which were nearly worn out by a service of 101 days, the mileage being 21,210 and the number of stops being over five thousand. These records must be considered as entitling this form of brake shoe to careful consideration. The claims for it are strong and they appear to be justified. Mr. W. W. Whitcomb is President and General Manager of the company, with office at 620 Atlantic avenue, Boston, Mass.

The Future of Fuel Gas.

The supply of fuel gas in cities for household use and for the generation of power is a question which is being discussed by the gas companies with a good deal of interest. At the recent meeting of the Western Association this subject was brought up, and the opinion was generally expressed that the chief prospect for extension of the business was in this direction. What can be done with fuel gas is shown by the experience of Pittsburgh and other cities with natural gas, and the supply of fuel gas in the city of Bridgeport in Connecticut is understood to be working well. The experiment of the Dominion Coat Company, at Halifax, in Nova Scotia, where the gas is obtained from by-product coke ovens, will be closely watched; it is said to be so far successful that the company is arranging its plans for the full installation of the larger plant to supply Boston and the adjoining cities.

We believe, as we have heretofore said on many occasions, that the ultimate solution of the question should be in the establishment of great plants at the mines, where the coal could be converted into gas, and from which it would be piped to the cities. A plan of this kind is said to be under consideration in Pittsburgh, and an investigation of the cost of producing power under different circumstances is being made for that purpose. It is said that the parties concerned believe that with the cheap and abundant supplies of coal accessible, the use of the best plant, and careful attention to the saving of by-products, power can be supplied from the Pennsylvania and West Virginia mines at quite as low a cost as it is obtained at Niagara Falls. It is to be hoped that the experiment will be tried.—*Engineering and Mining Journal.*

American Electric Railroad System in London.

The latest addition to the system of underground railways in London will probably rank as the most important of all these lines before it has been very long in operation. It will be known as the Central London Railway, and, starting from the busy Liverpool Street Station in the city, it will run by way of Holborn and Oxford street, along the Northern side of Hyde Park to Shepherd's Bush, a distance of six miles and a half through the busiest part of London. The road will be about 65 feet below street level, and will be carried in two separate and parallel tunnels—a similar plan to that adopted in the Southwark underground railway in the same city. Each station will be served by two elevators and two stairways.

The new undertaking has special interest for Americans, from the fact that the electrical equipment of the road itself and of the extensive system of elevators by which it will be served will be furnished by American firms.

The third rail equipment will be put in by the English representatives of the General Electric Company—the British Thomson-Houston Company. It will be similar in its general outlines to that which was employed by the General Electric Company on the New York, New Haven & Hartford Railroad.

The conductor will consist of an insulated third rail, placed on the ties betwen the main rails. The system will differ from that on the New Haven road, however, in that the trains will be hauled by separate electric locomotives, whose general appearance will conform to the well-known heavy locomotives which are used in the belt line tunnel at Baltimore. On the New Haven line, it will be remembered, the motor cars have accommodations for passengers. The change is made to accommodate the reduced clearance of the tunnels. Equally interesting will be the extensive elevator equipment. There will be 49 elevators in all, and they will be of the well-known double drum Sprague type. Their capacity will be 100 passengers per trip, or a load of about 15,000 pounds. This constitutes a marked triumph of our electrical engineers, and it is no small compliment that such equipment is to be used in London.

Compressed Air in Machine Tool Operation.

An application of compressed air to the operation of planing machines, which will be of great advantage to that type of machines and add greatly to their efficiency, has been recently patented by Mr. Alexander Gordon, President of the Niles Tool Works Company.

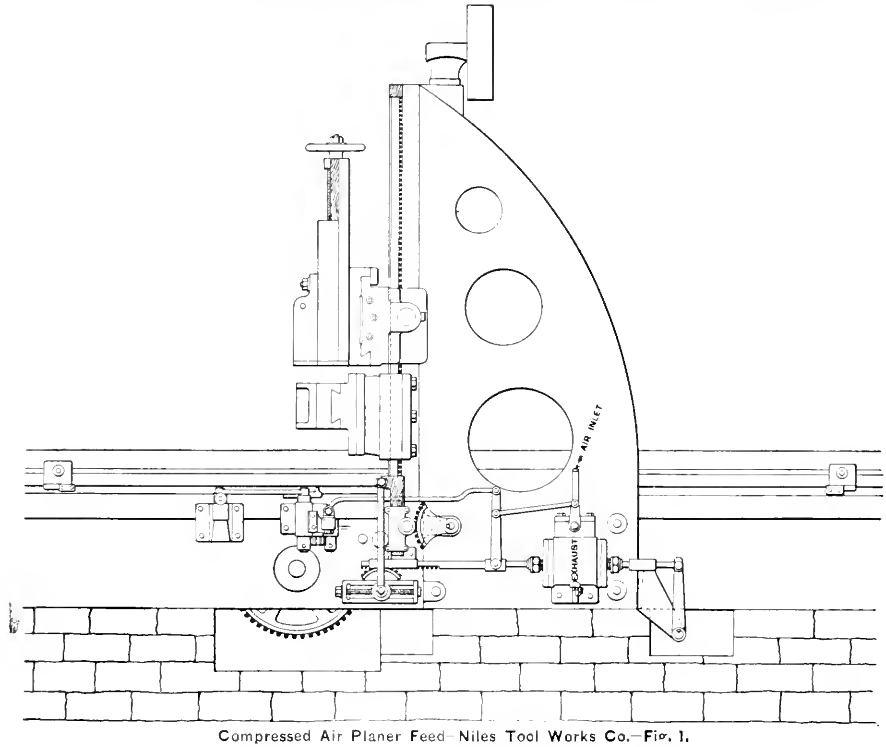
A wholly reliable and positive feed has long been desired and never has been fully attained. In Mr. Gordon's device the feed is actuated by air, and is stated to be absolutely positive and reliable, and practically unlimited in range. A quicker return than ordinarily obtained is desirable. By the operation of clutch-pulleys by air any desired speed may be obtained, and the mechanism is exceedingly simple, with but few parts and none subjected to excessive wear.

We illustrate herewith the patented pneumatic feed and quick return. The air is taken from the compressed air supply such as is now in use for general machine shop purposes, or from a small pump that may be attached to the machine in any convenient position and driven by a belt from the countershaft. It is carried from the pump or compressor through suitable pipes to the air cylinder that controls the feed and driving-clutch mechanism. A specially constructed valve admits it to the cylinder. This valve is operated through simple connections, fully shown, by the shifter arm and reversing tappets on the planer table. When the the table carries the tappet or dog against the reversing lever, instead of shifting the belts, as in the ordinary planer, it moves the valve-lever controlling the air admission to the cylinder. This instantly throws the piston in the cylinder to the opposite end, and carrying the rack to which it is attached forward or backward to operate the feed-rack. At the same moment the clutch operating the worm-shaft is thrown over, and the direction of the table-motion is reversed. This shifting arrangement is extremely simple and most efficient.

By examining the engravings it will be noticed that the piston rod is carried through the cylinder toward the back of the planer and is connected to a lever. The opposite end of this lever is attached to a rod running across and under the bed to the worm-shaft. On the worm-shaft end of this rod is a segment gear, whose teeth work into a short rack. The rack is attached to a rod, which moves the central member of the clutch from one pulley to the other, and the pulleys are operated one by a straight and one by a cross-belt. It will easily be seen how the reverse motion is obtained.

Figure 2 shows the clutch pulleys, bearings, sleeves and casing in section, exposing the clutch shifter rod in the interior of the worm shaft and clearly shows the various features of these parts.

The belts run continuously in one direction, thus preventing the excessive wear due to shifting, that due to overcoming momentum of pulleys and other parts, and to the rubbing of the edges of the belt in the shifter-eyes. The belts can be made as wide as the necessities of the case require, not being limited by any of the conditions always prevailing in other planers. The clutch, from its peculiar construction, holds most tenaciously under very slight pressure and is quite easily released.



Compressed Air Planer Feed—Niles Tool Works Co.—Fig. 1.

No adjustment is required in keeping the clutches in working order, as it has been shown that they will perform their duty until the wood facing is entirely gone, and the replacing of this facing or lining will not cost nearly as much as the repairs to and replacing of belts. This is believed to be an ideal machine for variable speeds, as the pulleys controlling the cutting speed can easily be made in the form of cones, and the belt may be shifted as on a lathe. The pulleys operating the return stroke could also be made in this manner, and the speed increased or decreased as the piece being planed was very heavy or very light.

We would sum up the peculiar merits claimed as follows:

Instantaneous, positive and maximum feeds.

Quick return, 6 or 8 to 1, with air cushion preventing shock.

Economy in operation and power required.

No shifting of belts, and, hence, freedom from such wear.

Variable speeds without the use of special appliances.

Simplicity in design, involving no complicated mechanism, nor necessitating other than the ordinary provision made for any other planer.

A number of these planers, from 32 by 32 inches to 10 by 10 feet, are in successful operation at The Niles Tool Works, and a 54-inch planer, for planing locomotive frames, with 35 feet traverse of table, is now under construction. The quick return on this planer is especially desirable by reason of its length and the comparatively slow speed of the cut.

Railroad Engineering at the University of Minnesota.

The demand for education in railroad subjects is being provided for by a number of the progressive technical schools and among them the University of Minnesota offers a special opportunity for studying in this line. The railroad department is under the direction of Prof. H. Wade Hibbard, who has had an extensive practical experience as a preparation for it. We have received a complete announcement of the various courses of the university and present the statement having special reference to the railroad field as follows:

Railway Mechanical Engineering.—A complete senior year is arranged for students wishing to specialize in this subject. The various courses may, however, be elected separately, subject to the requirements for previous preparation, to fill out the electives in the regular senior year of any department.

Students are encouraged to work, under special arrangements, in railroad shops during the summer vacations. This has proved its value as preparatory to the special work of the senior year. In every possible way the methods of the department are intended to place the student thoroughly in touch with the best railroad work; keeping always in sight the limitations to strict theory which railroad experience has found financially and practically to exist.

The location of the university is particularly favorable, being between the cities of St. Paul and Minneapolis, in proximity to the shops, yards and headquarters of the extensive railway systems of the Northwest, with which the department is in closest touch. The Northwesst Railway Club, meeting monthly for papers and discussions, is open for the attendance of students, while several are enrolled as members. Instruction upon the air-brake was given for 1897 in the special air-brake instruction car of the Great Northern Railway by Mr. M. E. McKee, Superintendent of Airbrake.

In locomotive testing valuable experience was gained during last year by road tests of two simple and three compound locomotives. These were complete tests of boiler and of engine, with dynamometer car, following the standard directions of the Master Mechanics' Association. Half the tests were made under usual working conditions, and half with a second locomotive and expert braking crew behind the dynamometer car so that the test locomotive ran at constant power and speed up and down all grades.

Students have frequent reference to a personal collection of over 1,500 blue-prints and drawings, carefully catalogued for easy access, from the leading railroads and locomotive builders of the country and the number is continually increasing, As these date from 1867 to the present, they well illustrate the past progress in railway and shop equipment, as also the present "state of the art." There are also complete files of the Proceedings of the American Railway Master Mechanics' Association and the Master Car Builders' Association.

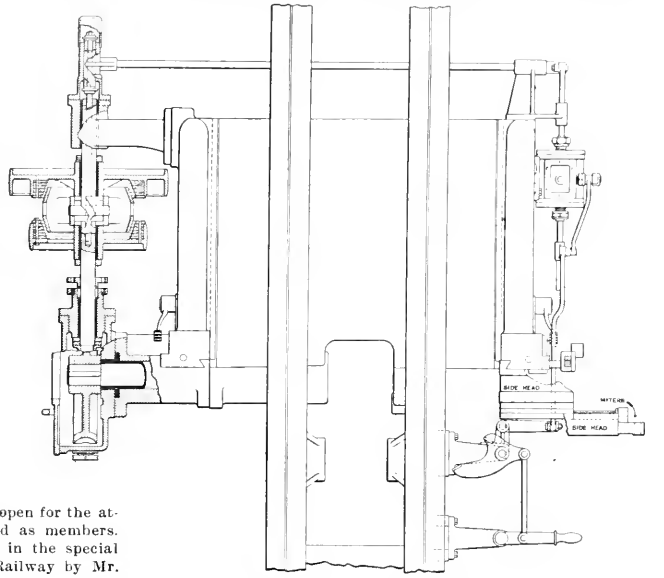
The Library of the department contains a collection of historic and recent works, the best standard books being purchased as soon as issued. There are a number of complete files of the transactions of engineering socities and of the leading technical publications. The reading-room is amply supplied with both the general mechanical and railway press.

Journal Club.—This is conducted through the year for the reading and discussion of the current engineering literature and the student is instructed in the making of a "card index" of the subjects and references. The continued growth and use of this method of preserving information in a readily accessible form has been found exceedingly valuable in school and later professional work. The training in easy, clear and concise speaking, by describing machines or processes of railway and general mechanical engineering, afforded by the club, is also beyond value for the future advancement of the technical graduate.

Visits of Inspection.—During the year numerous visits are made to the manufacturing plants of St. Paul and Minneapolis, which have proven to be of great value in supplementing the class-room work.

A Much Neglected Item of Shop Management.

The starting point in comparisons and estimates concerning work which is to be done in manufacturing shops is the cost of doing it. The railroads are not manufacturing to sell, but it is scarcely less important for the actual cost of production to be known for that reason, and it is probably true that very few shop foremen and their immediate superiors are able to give prompt and satisfactory answers to questions concerning the expense of conducting the various operations of their shops. The successful use of the piecework system depends very largely upon reliable knowledge of this kind, and the care in watching the accounts which is followed by the manufacturing concerns is really necessary in all branches of railroad work if economical methods are to be employed. The commercial side of shop work is important, and many a man and many a concern has failed for lack of attention to it. Mr. H. M. Lane read a paper upon shop accounting for the purpose of determining selling price, before the American Society of Mechanical Engineers, which is of interest in this connection, from which the following is taken:



Compressed Air Planer Feed.—Fig. 2.

With a view to conforming to the best practice of our largest and best shops in their methods of handling the details entering into the estimates and statements, information was asked from, and cheerfully furnished by, the heads of about 40 concerns in different branches of the machine business in widely separated localities. By one it was suggested that this is a commercial and not an engineering question. But as a mechanical engineer without the commercial instinct would be unable to earn enough to pay his dues in this society, it is assumed that all members in good and regular standing possess that instinct and consider the subject germane to the objects of our organization. It is gratifying to note that as a rule the larger and more prosperous the concern

the greater the interest in the subject and the fuller the answers to inquiries as to their methods. One manufacturer relates that he can never reconcile the profit on any or all articles manufactured by his company as figured by their method and their bank account at the end of the year. Another incidentally proves in stating his method (?) that small work cannot be as cheaply produced in a large as in a small shop even when the general expense is already met by the large work. Another remarks as to determining selling price: "Oh, we let the other fellow do that." Subsequent inquiry, however, showed an accurate knowledge of the difference between the shop cost of the correspondent's goods and the "other fellow's price."

The following method is obtained by selecting and re-grouping from the best practice those features which seem most desirable. Shop cost is the sum of—

1. Producer's labor.
2. Cost of material, including freight, hauling and waste.
3. Plant charge.
4. Burden.

The items, producer's labor and cost of material require no explanation.

Plant charge is an hourly charge for machine tools independent of, and in addition to, the hourly charge for operator, and covers interest and depreciation of the value of the particular tool and the tool's share of the entire cost of power and power distribution, and in shops using tools varying greatly in size, value, power required and amount of transmitting, machinery involved will be found to vary from less than one cent to over 40 cents per hour. This hourly tool charge, when once established, is not likely to vary materially, and it is listed and used by the cost clerk in the same manner as the hourly rate of a workman.

The "burden," an appropriate term met with only in the reply of Fraser & Chalmers, is the sum of all expenses chargeable to the shop except producer's labor and material.

The Westinghouse High-Speed Brake.

A new development of air-brake apparatus has been perfected by the Westinghouse Air Brake Company, for the purpose of improving facilities for stopping trains which run at extremely high speeds. It has been in use on the New York Central & Hudson River Railroad on the "Empire State Express" trains for three years and is best illustrated and described in a book just issued by the brake company, from which the following is taken:

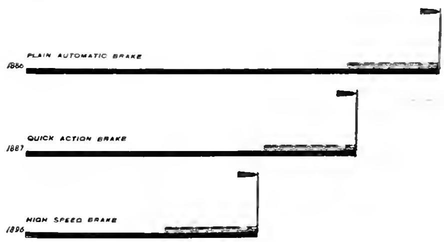
Under the conditions which have hitherto prevailed, it would seem that the quick action brake has fully met the requirements of the times. The more recent practice, however, of regularly running such trains as are now operated between New York and Buffalo, and New York and Washington, undoubtedly introduces more exacting demands for the prompt control of speed by the air-brakes, if a higher efficiency can be attained with equal reliability. So far as is now known there is but one method of increasing the efficiency of the quick action air-brake; and, realizing the importance of the new demands, advantage has been taken of this single avenue in securing the increased efficiency of the brake.

The Westinghouse-Galton experiments, carried on in England in 1878, first demonstrated that, while the adhesion between the wheel and the rail—which causes the wheels to persist in their rotation—is practically uniform at different speeds, the friction between the brakeshoe and the wheel—which resists the rotation of the wheel, and thereby stops the train—is considerably less when the wheels are revolving rapidly than when they revolve slowly. It was thereby demonstrated that a greater pressure could not only be safely applied to the wheels by the brakeshoes, at high speeds, but also that such considerably greater brakeshoe pressure must be applied in order to resist the motion of the train as effectively as with the more moderate brakeshoe pressure at low speeds. More recent investigations by the Master Car Builders' Association in this country have fully confirmed the results demonstrated in the Westinghouse-Galton experiments.

During the progress of the experiments in England, special mechanisms, of a somewhat delicate character, were employed with the old automatic brake to regulate a variable pressure of the brakeshoes upon the wheels—beginning with a considerable pressure at high speeds and reducing to a moderate pressure when the speed became much reduced—whereby much shorter train stops were secured than had ever been attained in any other way. No practical application of this apparatus was made in regular service, however, chiefly for two reasons: One was that the conditions of regular train service did not appear at that time such as to necessitate the utilization of this principle; the other was that, as already indicated, the regulating appliances there used were of a somewhat delicate and complicated nature, which appeared to be inconsistant with that exacting element of complete reliability which must characterize an air-brake apparatus.

With the invention of the quick action brake, however, the presence of the emergency brake, in addition to the ordinary automatic brake for service use, prepared the way to an entirely practical application of the principle so long ago discovered, by means of simple and reliable mechanisms. Fortunately, too, the improved brake gear, realized in the modern standards of the Master Car Builders' Association, is found to be adequate for such an increased duty as is imposed upon it in producing the increased brakeshoe pressures which are utilized at high speeds by the high-speed brake.

The apparatus of the high speed brake is very simple. It consists of the quick action air-brake apparatus, as ordinarily applied to a passenger car, to which is added an automatic reducing valve

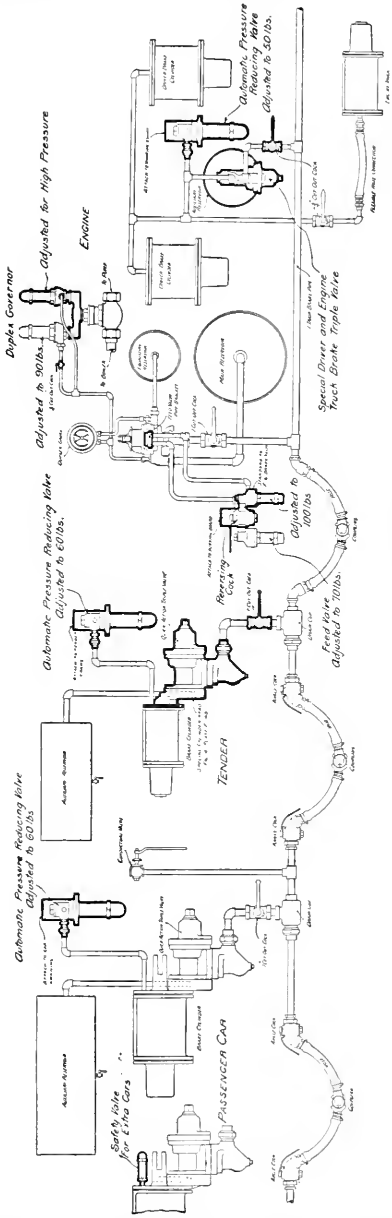


Development of the Westinghouse Air Brake.

that is adapted to be secured quite readily to the car sills or to any point in the vicinity of the brake cylinder, to which it is connected by means of suitable piping. It is, therefore, only necessary to add this pressure reducing valve to the quick action brake apparatus, already in use upon any passenger car provided with standard brake gear, to convert the apparatus into the high-speed brake. This automatic pressure reducing valve is so constructed that it remains inert in all service applications of the brake, unless, at any time, the brake cylinder pressure becomes greater than 60 pounds per square inch (for which the pressure reducing valve is ordinarily adjusted), in which case the reducing valve operates to promptly discharge from the brake cylinder as much air as is necessary to restrict the cylinder pressure to 60 pounds. It will thus at once be apparent that the maximum brake cylinder pressure, in all service applications of the brakes, is restricted to 60 pounds, regardless of the air pressure normally carried in the train pipe and auxiliary reservoirs. In an emergency application of the brakes, the violent admission of a large volume of air to the brake cylinder (only made possible by the quick action feature of locally venting the train pipe) raises the pressure more rapidly than it can be discharged through the capacious service port of the reducing valve, and the port thereby becomes partially closed, restricting the discharge of air from the brake cylinder in such a manner that the pressure in the brake cylinder does not become reduced to 60 pounds until the speed of the train has been very materially decreased.

In order to cause this apparatus to become practically effective for producing the increased stopping efficiency, the pressure of the air carried in the train pipe and auxiliary reservoirs is increased from 70 pounds (the customary standard) to about 110 pounds per square inch. With this pressure in the train pipe and auxiliary reservoirs, an emergency application of the brakes

almost instantly fills the brake cylinders with air at nearly 85 pounds pressure, thereby increasing the braking force from about 90 per cent. (the customary standard) to about 125 per cent. of the weight of the car: or, in other words, the pressure of the brakeshoes upon the wheels is about 40 per cent. greater, at this instant than is realized by the mere use of the quick action brake. The air pressure immediately begins to



Westinghouse High-Speed Brake—General Plan.
The Heavy Lines show New Parts.

escape from each brake cylinder, through the automatic reducing valve, aud continues to do so until the brake cylinder pressure becomes 60 pounds, which is thereafter retained until the brakes are released by the engineer.

On account of the high pressure normally carried in the auxiliary reservoirs (110 pounds), a full service application of the brakes (charging the brake cylinders with air at 60 pounds) may be made, and still leave the pressure in the auxiliary reservoirs at nearly 100 pounds. If, after releasing the brakes, a second application of the brakes should be called for before there has been time to recharge the reservoirs, there is abundant air yet stored in the reservoirs to make a second, and even a third, full service application, and still leave sufficient air pressure to make an emergency stop equal to that of the ordinary quick action brake. These advantages, coupled with such a restricted brake cylinder pressure for all service applications of the brake, that wheel sliding is entirely avoided, require no further comment to insure recognition of their importance upon trains of unusually high speed. By simple additions to the brake apparatus on the locomotive, the train pipe pressure is easily and quickly changed to 70 pounds, when the locomotive is used in other kinds of service, and vice versa.

As a first consideration, high stopping efficiency of the brakes demands that every wheel of the entire train shall be fitted with a brakeshoe. The practice, in times past, of applying brakeshoes to only four of the wheels of six-wheel trucks has been almost universally abandoned upon conviction of the fact that such at practice impairs the efficiency of the brakes by 33 per cent. The importance of efficient brakes upon the locomotive driving wheels is also fully recognized. In addition, however, experience with the use of brakes upon the leading locomotive truck has demonstrated the entire practicability of applying brakes to the wheels of the engine truck, and it may be unhesitatingly stated that proper security for high-speed trains requires the application of brakes to every wheel in the train. Trains scheduled to run at exceptionally high speeds are necessarily limited in respect to their weight and length, while powerful locomotives are required to haul them. It thus occurs that the weight carried to the rails by the leading truck of a locomotive is about one-twelfth that of the whole train. Neglect to provide brakes for the locomotive truck upon such trains robs the stopping efficiency of the brakes by nearly 10 per cent. It seems manifestly inconsistent to neglect such an important factor in brake efficiency, and the use of the locomotive truck brake is therefore considered an essential in every case where the superior stopping efficiency of the high-speed brake is desirable.

The high-speed brake apparatus was introduced into practical service upon the "Empire State Express" trains of the New York Central & Hudson River Railroad three years ago, and has continued in most satisfactory service since that time. During all that time, while the brake apparatus has rendered exceptionally efficient service, not a single case of slid flat wheels has been reported from the cars of those trains.

Early in October, 1894, a system of experiments with the brake, in comparison with the ordinary quick action brake, was made upon a passenger train of six cars upon the Pennsylvania Railroad. These experiments were made upon a falling grade of about 30 feet to the mile, and uniformly demonstrated that, at a speed of 60 miles per hour, the emergency stops with the high-speed brake are more than 450 feet shorter than with the ordinary quick action brake. Since that time the "Congressional Limited" trains of the Pennsylvania Railroad, running between New York and Washington, have been equipped with this apparatus, which has operated in a most efficient and highly satisfactory manner.

The record of the brake upon the fast trains of the New York Central and Pennsylvania railroads has not only demonstrated the superior efficiency of this brake apparatus, but also fully justifies confidence in the thoroughly pratical and reliable character of the apparatus.

The large diagram has been prepared to show the special high-speed brake mechanisms used in combination with the existing brake apparatus on locomotives and cars, and several illustrations are given which will make clear, with the following description, the construction and operation of the automatic reducing valve used therewith, and its adaptation to a passenger car brake.

Fig. 1 shows a vertical cross-section and Fig. 2 a horizontal cross-section through the slide valve of the reducing valve, which, in practice, is attached to some convenient point on the car or engine by its bracket *X*, and is connected to the brake cylinder by piping thereto from union swivel 15, Fig. 5, at *Z*. It will be manifest that chamber *a* is at all times in communication with the brake cylinder and that piston 4 will be subject to whatever pressure may be therein, while an adjusting spring, 11, on its opposite side, provides resistance to its movement downward, which is limited to chamber *c*, or until it strikes the upper surface of spring case 3. This assistance can be readily varied by adjusting nut 12 as may be required. Combined with piston 4 is its stem 6, fitted with two collars, between which slide valve 8 is carried and moved coincident with the movement of piston 4 when subjected to air pressure from the brake cylinder and such pressure is in excess of the resistance of spring 11. Slide valve 8 is represented by cross-hatched lines in Figs. 3, 4 and 5, and is fitted with a triangular shaped port, *b*, in its face, which is always in communication with chamber *d*, while a rectangular form of port, *a*, is arranged in its seat and is always in communication with the outside atmosphere at exhaust opening *Y*.

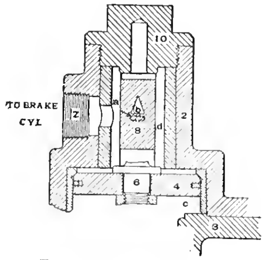


Fig. 3.—Position of Ports at Release.

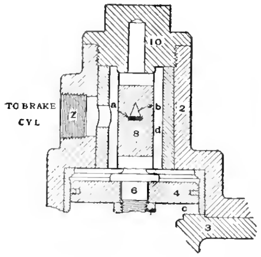


Fig. 4.—Position of Ports in Service Stop Pressure Exceeding 60 lbs. in Brake Cylinder.

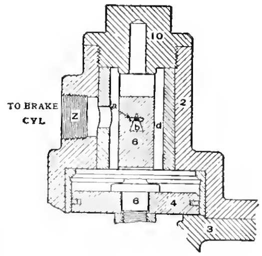
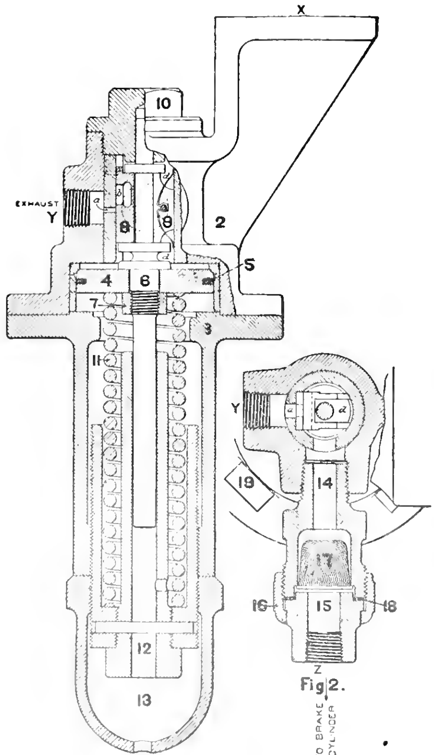


Fig. 5.—Position of Ports in Emergency Stops.

The Automatic Relief Valve of the Westinghouse High-Speed Brake.



Sections of Valve.

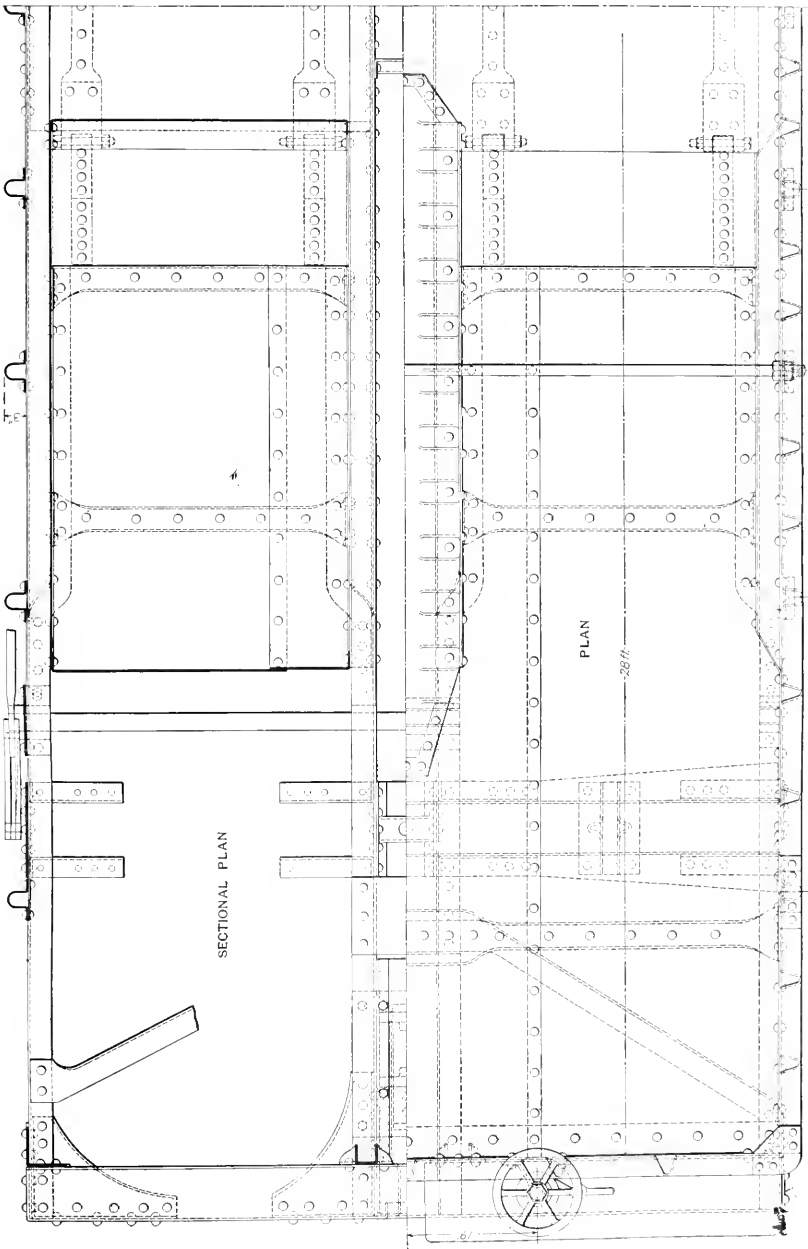
In Figs. 1 and 3 the slide valve 8 and its piston 4 are shown in the normal position occupied so long as the pressure in the brake cylinder does not exceed 60 pounds per square inch, when used with passenger car brakes, or 50 pounds when used with driver brakes, suitable adjustment for either pressure being made by compressing or releasing the tension on spring 11. It will be noted that port *b* in the slide valve 8 and port *a* in its seat in this position are not in register and the pressure is therefore retained in the cylinder until the release of the brakes is effected in the usual manner.

When the pressure in the brake cylinder exceeds 60 pounds, with an ordinary service application of the brakes the pressure acting on piston 4 moves it downward slightly until port *b* in the slide valve and port *a* in its seat are brought into register, as in Fig. 4, enabling the surplus air to be vented to the atmosphere, when spring 11 forces the piston and slide valve to their normal position, as in Figs. 1 and 3, closing the exhaust and retaining 60 pounds pressure in the cylinder. The area of ports *a* and *b* is such that in performing the function just described they are enabled to discharge the surplus air from the brake cylinder to the atmosphere quite as rapidly as it enters the brake cylinder through a port in the slide valve of the triple valve of somewhat smaller area.

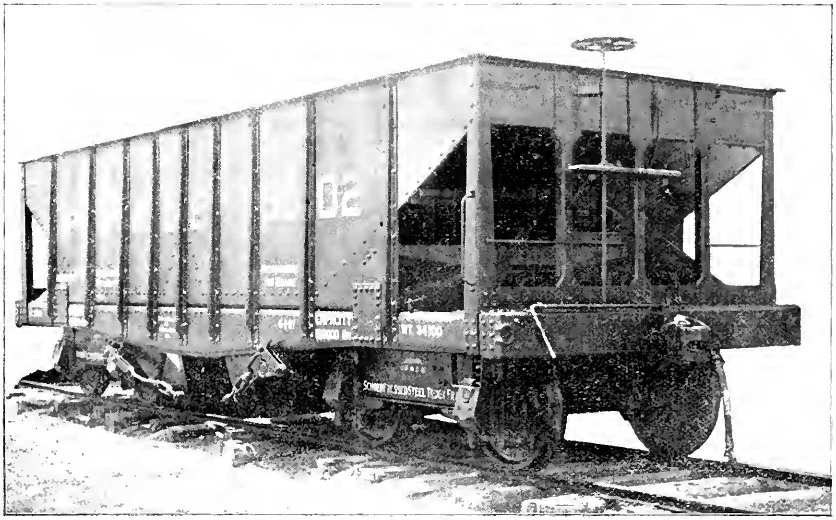
The position taken by the piston 4 and slide valve 8, in an emergency application of the brakes, is shown in Fig. 5. The violent admission of air to the brake cylinder suddenly drives piston 4 throughout its entire traverse, until it rests on spring case 3, when the apex of port *b* in the slide valve is brought into conjunction with port *a* and a comparatively restricted exhaust of the brake cylinder air takes place while the train is at its highest speed, gradually increasing as the pressure on piston 4 is lessened and slowly moves the slide valve upward, in a degree proportional with the reduction of the speed of the train, until, finally closing, the desired pressure is retained in the the brake cylinder until released in the ordinary manner. In performing this function, air pressure in a large volume is discharged into the brake cylinder from both the auxiliary reservoir and train pipe through openings largely in excess of the area of ports *a* and *b*, which latter are consequently unable to discharge it to the atmosphere with equal rapidity, enabling piston 4 to be quickly driven throughout its entire possible traverse and the apex of port *b* is presented to port *a*, giving an area through which the excess air is slowly discharged to the atmosphere, but gradually increasing in a required degree as the piston and slide valve ascend to their normally closed position.

The Schoen Steel Cars.

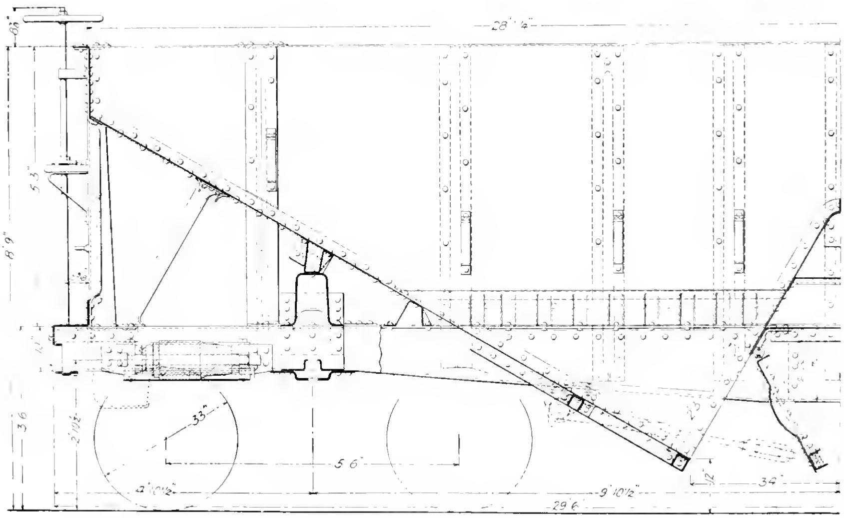
In our accounts of the recent conventions at Old Point Comfort the pressed steel cars recently built by the Schoen Pressed Steel Company, of Pittsburgh, Pa., were mentioned as a feature which marked progress in the construction of metallic cars. These cars, two of which were exhibited at the conventions, were built as a part of the order of 600 for the Pittsburgh, Bessemer & Lake Erie Railroad, the designs, including the trucks, being by Mr. Charles T. Schoen. The cars have a capacity of 100,000 pounds and are of the double-hopper gondola type. Through the courtesy of the builders we are enabled to illustrate and describe their construction, which is of peculiar interest at this time because of newness of the art of building heavy steel cars and because of the engineering work which is embodied in the arrangement of the parts for the purpose of securing lightness



Steel Cars, 100,000 Pounds Capacity—Pittsburgh, Bessemer & Lake Erie Railroad.
Designed and Built by the Schoen Pressed Steel Co., Pittsburgh, Pa.



Schoen Steel Car.



Schoen Steel Car—Half Longitudinal Section.

together with the necessary strength. These cars weigh only 34,100 pounds each as against 39,950 pounds for a somewhat similar design brought out by the Carnegie people last year, the difference between the two weights being due chiefly to the substitution of pressed steel for rolled shapes.

The trucks were illustrated in our issue of August 1896 and readers are referred to that description for details concerning them. The new cars are built upon an underframe consisting of four longitudinal sills of channel form which are 17 inches deep at the center, tapering down to 10 inches at the ends. The sides consist of continuous plates stiffened by verticals of steel pressed into a form giving a U section and for futher stiffening the side plates are flanged inward at the top and bottom edges. The bottom flange is riveted to the top flange of the side sill. The body bolsters are rectangular in form and are placed upon the tops of the longitudinal sills; they are lower at the ends than at the center, as shown in the drawings aud this feature permits of using the surplus material from the ends as gusset bracing to strengthen the car against twisting stresses. The half sectional and half end view illustrates the manner in which the ends of the bolsters are turned up against the sides of the car in order to permit of a secure form of attachment without interfering with the riveted joint between the sides and the side sills. The longitudinal section and plan views show the form and attachment of the end sills, which are of a single plate gusseted to all of the sills. The hoppers provide ample transverse stiffening and longitudinal pressed and ribbed roofs over the center sills brace the hoppers lengthwise of the car. There is a transverse roof between the hoppers, which, together with the transverse supporting channels for the floors of the hoppers, furnish the lateral tying of the car body. The cars are equipped with the Westinghouse friction draft and buffing appliance and nickel steel axles. The journals are 5 by 9 inches, and the proportion of nickel in the axles is about 3 per cent. The symmetry and simplicity of construction were commented upon by many who saw the cars at the conventions. These points were effected by the innovation of the designer upon the old practice of designing metal structures. Instead of using rolled sections, such as channels, eye-beams and angles, as is common among structural engineers, he has resorted to the use of pressed-steel shapes entirely, taking steel plate and pressing it into the correct shape to get the greatest strength with the least weight. For example, look at the sills. It will be noticed that they are of channel section. A channel made in this way is just as strong for the strains to be met as though it were 17 inches deep throughout its entire length, and a saving of probably 30 per cent. in dead weight is made. This idea has been followed throughout the entire structure, with the result that, as it is estimated, a saving of about 4,000 pounds is gained over the practice of using rolled sections, and probably 6,000 or 7,000 pounds

is gained over the use of a wooden structure of equal capacity.

A great reduction in the number of parts is effected. For example, the side sheeting is all one piece and flanged at top and bottom, thus avoiding the necessity of riveting angles around these points. The floor sheeting is flanged on the edges, making only one row of rivets necessary instead of two rows, as would be the case were the floor attached with angles to the sides. Throughout the entire structure this idea has been carried out, and the riveting required is only about two-thirds of what would be required for a structure of rolled sections. This reduction of parts is an important feature, because, aside from the other advantages, it is one of the sources of economy in maintenance.

Electricity Under Steam Railway Conditions.

BY GEORGE S. STRONG.

(Second Paper.)

One of the arguments of the advocates of electricity for steam railway conditions is, that on stationary plants a lower grade of coal can be used to advantage than can be used on ordinary locomotives, and one company experimenting with electricity on one or two of its branch lines makes a great point of its ability to burn sparks taken from the front ends of its ordinary locomotives, and states that from 700 to 800 carloads of such sparks are produced per month on its lines and that one ton of these sparks is equal to a half ton of coal.

With properly designed locomotives, this condition of things would not obtain, as it has been thorouhgly and abundantly demonstrated that, with a properly designed locomotive firebox, these same sparks can be burned on a locomotive, and that such an engine will take the finest slack of bituminous coal and burn it without throwing any sparks, without taking them out of the firebox and without making any smoke. This is only a question of sufficient grate area to burn enough coal to do the work without lifting the coal off the grates.

This can be accomplished by two methods—by employing large grates and large boiler capacity, or by what is better, a combination of large grates and boiler capacity with compounding, which reduces the demands on the boiler, and also reduces the fierce blast to a gentle fanning action of the fire, greatly increasing the evaporation per pound of coal, as well as reducing the quantity of water to be evaporated.

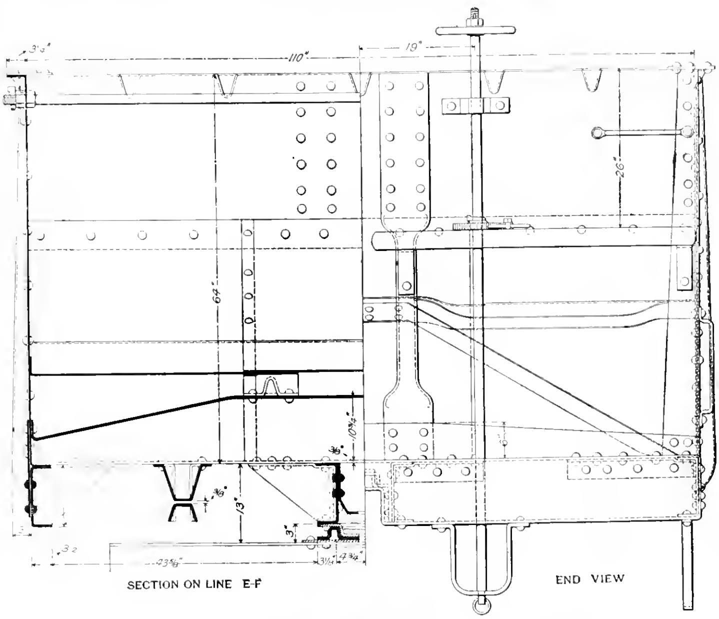
If the railroad that is displaying so much energy in its electrical experiments had displayed the same kind of zeal in locomotive improvements, it would not to-day have from 700 to 800 carloads of sparks to pay for each month.

This spark question, and also the smoke question, for all roads having a large suburban business, are giving much trouble, and must be met in some way. As soft coal seems to be the fuel from which our power for all purposes must come, because anthracite is becoming too expensive for power purposes especially in locomotive work, there are two reasons why railroads having a large suburban population to deal with should overcome the smoke and spark nuisances. The first one is, that it would save them a large amount of money in not having the ballast and roadbed filled with black carbon, which is picked up by every passing train and creates a nuisance, soiling the cars inside and out, and adding greatly to the cost of painting as well as to the uphosterers' bills. This also constitutes a nuisance for all the residences situated near the tracks.

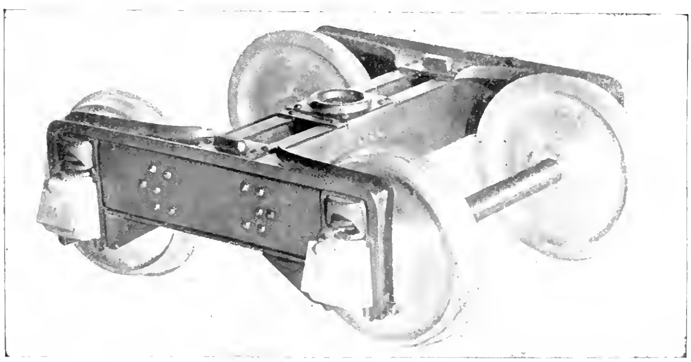
The most promising remedy seems to be in the coking of the coal at the point where it is to be used, in modern by-product ovens, and using the gas from these ovens for fuel for the suburban work, as compressed gas, either on steam motor cars for main line work where high speeds have to be made between stations, or on gas motor cars for street-car work, and for feeders—the latter class of cars doing all work where it is not desired to run faster than 30 miles per hour, and the steam motor cars doing work that required speeds up to 60 or 70 miles between stations.

Recent tests of a gas-motor car in Germany demonstrated its ability to move a ton one mile for from three quarters to one cubic foot of gas. According to Mr. Davis' figures for electric traction one pound of coal moved 2,500 pounds one mile. One pound of coal has 10,000 available heat units, while one cubic foot of coal gas has 750, or one pound of coal has $13\frac{1}{3}$ times the number of heat units that one cubic foot of coal gas has. If the electric motor has been equally efficient with the gas motor, in proportion to the available heat units used, it would have moved $13\frac{1}{3}$ tons one mile, instead of $1\frac{1}{4}$ tons, so that we must conclude that the gas motor will do its work on one-tenth of the heat units required for electrical equipment.

From this and the foregoing figures we must also arrive at the



Schoen Steel Car.



Schoen Steel Truck.

conclusion that the steam motor car with gas as fuel, and allowing $33\frac{1}{3}$ cubic feet per horse-power per hour will use about one-fifth of the heat units that would be required to do the same work by electricity, as proposed by Mr. Davis and other electrical engineers. This is largely accounted for by the great losses outlined in the first paper, and by the fact that with the gas motor car, either using steam or by the direct use of the gas engine, the power is also generated as used, and if there be not a demand for power, no heat is being produced, and the gas reservoir is a reservoir of power to be drawn on at will and is always ready to respond instantly, without waiting to distill gas and then burn it to make heat, as in a stationary plant. The value of this feature is well illustrated by the use of gas stoves for cooking, where gas costing $1.25 per thousand is burned in competition with anthracite coal costing $5.75 per ton, and it is found that the same work can be done for about one-half of the cost by the use of gas, as it is only burned while actually required, while the coal fire has to be kindled and allowed to burn out, producing much more heat than is wanted, and producing it at a time when it cannot be utilized.

As to the economy of the use of gas as fuel for a steam motor, it has certain very great advantages. It can be burned so as to produce perfect combustion at all times, and need only be burned when there is work to be done. In this respect, it is somewhat like electricity as applied to stationary motors or machine tools, inasmuch as by keeping a small jet lit in the firebox and regulating the gas supply by the steam pressure, gas is not used unless there is a demand for steam, and then it is ready and is almost instantaneous in its action to respond to a demand for a quick fire; while, with an ordinary locomotive in this kind of service, a fire is maintained at all times and of about equal intensity, while the actual working time of the engine is but 25 to 30 per cent. of the time from the time the fire is built until it is banked again. This loss as was pointed out in the first paper is equally great with a stationary electrical plant that is subject to great fluctuation of load.

While the heat units in a pound of burning carbon are 14,000, the ordinary American coals are not pure and have a large percentage of ash, moisture and other impurities, so that it is generally considered that an average coal has about 10,000 available units of heat, which, for a net ton, would give $2,000 \times 10,000$, or 20,000,000 heat units; while a cubic foot of good coal gas has 750 units. A thousand feet would have $750 \times 1,000$, or 750,000 heat units, which would theoretically call for the use of 26,660 feet of gas to equal a ton of coal.

Practically, for the reasons stated above and by reason of the more perfect combustion of the gas, not more than 13,333 cubic feet would be required to do the work of one ton of coal. This would be allowing $33\frac{1}{3}$ feet to the horse-power developed, or about double what is found necessary in the best modern gas engines. But, it may be asked, What is to be done with the large quantity of coke produced, and how much will the gas cost per thousand to make? To the first question I would reply that the coke should be used as the regular fuel of the road for all passenger trains not operated by gas, and if there is any surplus it should be used on freight, and with properly constructed fireboxes and compound engines it will be found to be excellent fuel and will eventually do away with both the smoke nuisance and the spark question, for the volatile matter will all have been taken out of it by the coking process and, the coke being solidified into chunks, it offers greater resistance against the blast and is not so readily lifted from the fire as is the fine air-slacked coal. But one may say that it will not make steam as freely. With a proper firebox there is no trouble on that score. It has been used successfully for years on many roads, simply to get rid of the smoke, and because it is cheaper than anthracite; but these roads have purchased it in the coal regions and it costs more purchased in that way than if made as proposed. I give below five tables on cost of making coke and saving the by-products, one being at the mines in Pennsylvania, one contemplating burning the gas on the ground, one piping it to a near-by town and selling it, and one on taking the coal to where the coke was to be used and selling the gas there at 30 cents per thousand cubic feet. The fourth table is assumed for a city where good soft coal is delivered on the tender at $1.25 per ton, and where the coke is of equal value for locomotive fuel and the amount of coke from the given quantity of coal is to be delivered to the locomotive department at the same price as coal would cost. Allowing 10 cents per thousand as being the value of the gas for street-car and suburban work, for gas motor cars, $58\frac{14}{17}$ horse-power hours would be obtained for 10 cents, and on steam motor cars, allowing $33\frac{1}{3}$ cubic feet per horse-power, $30\frac{1}{3}$ horse-power hours would be obtained for 10 cents. If we allow 13,333 feet of gas to do the work of one ton of coal on an ordinary locomotive or an electrical plant, it would be equivalent to coal at $\$1.33\frac{1}{3}$ a ton; or, if used on the gas motor, where only 17 feet of gas are required for one horse-power, and only 6,800 cubic feet are required to do the work of one ton of coal on an ordinary locomotive or an electrical plant, it would be equivalent to coal at 68 cents per ton to accomplish the same results.

The above figures and facts in regard to the possibilities of coking and gas production for this kind of work are taken from actual practice and can be substantiated, and it would seem as if they were worthy of careful consideration by railroad men who are contemplating some change to meet electrical competition.

If it be not desired to use coke as fuel on locomotives, then a ready sale for it can be found in any city in the country for domestic, foundry and furnace purposes. The price to-day of crushed coke in the city that I have mentioned as being able to supply coal at $1.25 on the locomotive tenders is $4.30, and anthracite coal for domestic purposes costs from $6.50 to $7; and as this city is the largest market in the United States for pig iron, it is naturally supposed to be a good distributing point for coke for furnace and foundry purposes; again, as the smoke question is one that has given great annoyance, the introduction of large quantities of coke for domestic purposes at a reasonable price would go a long way toward the solution and problem. For this reason the writer gives a table of the cost and profits of the operation of a coking plant at this point, the gas being used and the coke being sold at present market prices. The writer is informed by a dealer in coke and coal in another Western city that he supplies the gas company with its coal and takes all the coke and pays the gas company a large amount of money each year for the difference in value of the gas-house coke and the market value of the coal from which it was manufactured.

Now, we all know that there is no comparison between gas-house coke and good, clean, crushed coke, made in a coke oven. Crushed coke is about equal to the average anthracite, and is generally much freer from sulphur and ash, which make clinkers.

STATEMENTS OF OPERATIONS.

120 OVENS AT MINES.

EXPENSES.

840 gross tons coal for for oven coking in 30 hours.	
672 gross tons per day, at 55 cents	$369.60
Labor per ton coking, at 25 cents (541 tons)	135.25
Incidentals and repairs, at 20 cents	108 20
72 tons producer coal, at 55 cents	39 60
Producer's labor	24 00
	$676.65
General expenses, 25 per cent	169.16
	$845.81

RECEIPTS.

5,000,000 cubic feet gas, at 20 cents per 1,000	$1,000,000
161,000 liquor ounces ammonia, at 10 cents per 100	161.00
20 tons tar, at $7 per ton	140.00
541 net tons coke, at $4.20, less freight to Lehigh Valley, equal say $\frac{3}{4}$ cents per ton per mile, equal $1.40, equal $4.20, equal $2 at Connellsville, present price $1.50	1,514.80
Income per day	$2,815.80
Expenses per day	815.81
Net income per day	$1 969 99
	300
Net income per year of 300 days	$590,997.00

120 OVENS AT MINES, SURPLUS GAS USED ON THE GROUNDS.

EXPENSES.

672 tons coal, at 55 cents	$369.60
Labor	135.25
Incidentals and repairs	108 20
	$613.05
General expenses, 25 per cent	153 26
	$766.31

RECEIPTS.

2,000,000 feet surplus gas, at 2 cents per 1,000	$40.00
161,000 liquor ounces ammonia, at 10 cents per 100	161.00
20 tons tar, at $7	140.00
511 tons coke, at $2.80	1,514.80
Income per day	$1,855.80
Expenses per day	766.31
Net income per day	$1,089.49
	300
Net income per year of 300 days	$326,847.00

120 OVENS IN LEHIGH VALLEY.

EXPENSES.

672 tons coal, at $2	$1,344 00
Labor	135.25
Incidentals and repairs	108.20
72 tons producer coal, at $2	144.00
Producer labor	24.00
	$1,755.45
General expenses, same as at mines	169.16
	$1,924.36

RECEIPTS.

5,000,000 cubic feet gas, at 30 cents per 1,000	$1,500.00
161,000 liquor ounces ammonia	161.00
20 tons tar, at $7 per ton	140.00
541 tons coke, at $4.20	2,272.20
Income per day	$4,073.20
Expenses per day	1,924.36
Net income per day	$2,148.84
	300
Net income per year of 300 days	$644,652.00

PRODUCT OF 120 OVENS AT A POINT WHERE COAL IS WORTH $ 25, THE COKE IS TO BE BURNED ON LOCOMOTIVES.

EXPENSES.

672 tons coal, at $1.25	$840.00
Labor	135.00
Incidentals and repairs	108.00
72 tons producer coal, at $1.25	90.00
Producer labor	24 00
General expenses, including interest	155.00
	$1,352.00

RECEIPTS.

5,000,000 cubic fe t gas, at 10c. per 1,000	$500.00
161,0 0 liquor ounces ammonia, at 10 cents per 100	161.00
20 tons tar, at $7 per ton	140.00
511 tons coke, at $1.25	676.25
	$1.577.25
Net income per day	$225.25
Net income per year of 300 days	67,575.00

PRODUCT OF 120 OVENS AT A POINT WHERE COKE IS WORTH $1.30 PER TON AND COAL IS WORTH $1.25.

EXPENSES.

672 tons coal, at $1.25	$810.00
Labor, 25c. per ton of coke	135.00
Incidentals and repairs	108.00
72 tons producer coal at $1.25	90.00
Producer labor	24.00
General expenses, including interest	155.00
	$1,352.00

RECEIPTS.

5,000,000 cubic feet gas at 10 cents per 1,000		$500.00
Ammonia, 161,000		161.00
Tar, 20 tons at $7		140.00
511 tons coke, at $1.30		2,326.30
		$3,127.30
Income per day	$1,775.30	
Income per year of 300 days	$532,590.00	

Thermal Tests for Wheels.

Attention was called in our issue of June, 1896, to the fact that the Pennsylvania Railroad from investigations of the subject of failures of cast-iron wheels had instituted a thermal test, and the correctness of the idea is demonstrated by further pursuit of the subject. It might have been expected that such a radical departure in specifications for wheels as the requirement of thermal tests would cause considerable discussion before the Master Car Builders' Association, but the plan seems to be a needed improvement and was accepted as such. Mr. G. L. Potter stated the value of thermal tests in one of the noon-hour discussions as follows:

"During recent years the competition in railroad business has resulted in a marked increase in the speed and size of trains and in the size and carrying capacity of the cars. These new conditions developed weaknesses in some parts of the equipment and made it necessary to devise means that would reduce the failures of the important parts to the minimum.

"One more or less serious cause of wrecks is due to the breakage of wheels. In some cases the failures are due to want of proper inspection, whereby wheels which are worn through the chill, or have seams in the tread or other defects, are allowed to remain in service longer than they should. There is, however, one cause of breakage of wheels that the most careful inspection cannot prevent, namely, that due to the expansion of the tread caused by long and severe application of the brakes, frequently necessary on long, steep grades or in controlling heavy fast trains with a few air-brake cars, resulting in the tread becoming very hot, causing it to expand, thereby introducing strains in the wheel which it cannot resist.

"In considering the subject with a view to overcoming failures from this cause it was thought that the introduction of specifications requiring representative wheels to stand a test which would bring upon them the same strains that are produced by severe brake application, would result in producing wheels that would be safe to use under the most trying conditions. Such specifications, which are similar to those recommended by the committee appointed to report to this convention on 'Specifications and Guarantees for Cast-iron Wheels,' have been in use for a year or more, with very satisfactory results. The manufacturers experienced some difficulty at first in meeting the requirements of the specifications, but soon found that by the use of the proper metals and care in annealing, the difficulties could be readily overcome.

"The carrying capacity of freight cars having increased in a much greater ratio than the weight, and as the braking power that can be used on such cars is limited by the light weight of same, and with the greater speeds of to-day, the wheels receive much more severe punishment from the brakes than formerly, and as the amount of double tracks is constantly being extended, making it still more necessary to take additional precautions to prevent wrecks on account of the possibility of trains on the other track being wrecked also, wheels furnished under specifications requiring such thermal test as is now in use and as proposed by the committee to report on wheel specification will surely be safer to use than those furnished under no specifications or specifications requiring only a drop test, which subjects the wheel to shocks that it seldom, if ever, receives in service. It has been advanced that it is possible to make wheels that would meet the termal test, but that owing to the nature of the metal used (it being too soft or having other properties that would prevent it chilling properly) would not necessarily give good service in so far as wear is concerned, but this can be provided against by requiring the maker to guarantee the wheels to give a proper time or mileage service."

Henry B. Stone.

The death of Henry B. Stone, formerly Vice-President of the Chicago, Burlington & Quincy Railroad, which resulted from an accident at Nonquitt, Mass., July 5, removed one of the men of whom any country might be justly proud. He was but 45 years old, and his life was so full of promise that had he lived a few years longer, he would, without doubt, have made his name still more favorably and widely known. A friend who was close to him for 19 years says that he had come to regard him more and more as a man of exceptional ability. He was energetic, courageous, ambitious and industrious, and, withal, his was an uncommon integrity; in short, he was a type of the very highest standard of American citizenship. His railroad work, wherein his ability as an organizer and executive were brought out, was, perhaps, his greatest success, although he showed the same keenness and command of difficult situations in his later undertakings. His remarkable ability as an executive was seen in the conduct of the great C., B. & Q. strikes of 1888 when he was General Manager of that road. There are differences of opinion as to the wisdom of the policy which was then followed by him, but there can be no doubt of the fact that he put the wishes of his superiors into effect and in so doing he made use in a masterly way of every factor which could be employed to carry out the purpose in hand. It must be conceded that there are few positions as trying as was his at that time, and the fact that in the past nine years railroad strikes have been so few in number must in a large part be credited to him. It is significant that one of the men who stood under him at that time now says: "We always felt very sure that what Mr. Stone said and did would be right." He was conscientious and had the respect and confidence of his staff in all that trouble. His death cast a gloom over the employees of that road, though he had not been connected with it for seven years. The American Railway Association owes much of its present successful standing to Mr. Stone and his assistance in carrying through the project of the World's Fair in Chicago contributed materially to the ultimate success of that undertaking. He was highly honored by the Commercial Club of Chicago, in being sought among many broad-minded, progressive, successful men as its President, but declined.

Mr. Stone was educated for the bar at Harvard University, but owing to a tendency toward deafness, which was afterward overcome, he gave up that profession and took a course in mechanical engineering at the Massachusetts Institute of Technology. After graduation he became connected with an ordnance concern in Boston, and, while successful in that line, he found that the field was not in every way suited to his ambition, and in 1878 he resigned a position which was lucrative in order to take a position as journeyman machinist in the mechanical department of the C., B. & Q. Railroad, at Aurora. He was soon promoted to the position of gang foreman and always took great interest in an engine that was built under his supervision. After that he was employed by Mr. Challender, then Superintendent of Motive Power, on the special duty of investigating devices and methods that were being looked into and tested on the engines. His next promotion was to the position of Division Master Mechanic at Aurora. When Mr. Challender resigned Mr. Stone succeeded him as Superintendent of Motive Power Jan. 1, 1880, and was made General Superintendent in the fall of 1881. Subsequently he was made Assistant General Manager, and May 1, 1885, General Manager. Nov. 1, 1888, Mr. Stone was appointed Vice-President, and in 1890 he resigned to take the Presidency of the Chicago and United Telephone companies. Mr. Stone was a rare man, and of his life the chief lesson for young men appears to be the value of preparation by education and continuous study, coupled with indomitable perseverance and energy in fulfilling the trusts which were reposed in him. His selection of subordinates was wise, and his treatment of them was such as to bring out all their best capabilities, and these are now among his greatest admirers and sincerest mourners.

(Established 1832.)

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

28TH YEAR. 66TH YEAR.

PUBLISHED MONTHLY BY R. M. VAN ARSDALE, MORSE BUILDING..................................NEW YORK

G. M. BASFORD, Editor.

AUGUST, 1897.

Subscription.—*$2.00 a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union.*
Subscriptions for this paper will be received and copies kept for sale by the Post Office News Co., 217 Dearborn Street, Chicago, Ill.

EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Special Notice.—*As the* AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL *is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 25th day of each month.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* **When a subscriber changes his address** *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

The paper may be obtained and subscriptions for it sent to the following agencies: **Chicago,** *Post Office News Co., 217 Dearborn Street* **London, Eng.,** *Sampson Low, Marston & Co., Limited St. Dunstan's House, Fetter Lane, E. C.*

The suggestions with regard to the use of gas made by Mr. Strong in this issue in discussing the subject of "Electricity Under Steam Railway Conditions" are interesting, and in this connection attention is also called to the paragraph under the caption "The Future of Fuel Gas," which we reprint from a recent issue of the *Engineering and Mining Journal.* The utilization of the great wastes from coke ovens is a most praiseworthy field for the exercise of engineering thought and talent. Not the least important of the effects of the introduction of electricity into engineering operations is that other methods of producing power are likely to reach a higher degree of development on account of what is practically a rivalry between the different methods.

In view of the great advantages offered by uniformity or standardizing in the construction of machinery, it is unfortunate that so little attention has been paid to this matter in the designs of the machinery for the ships of the United States Navy. If too much stress were laid upon standards, progress and improvement might be sacrificed; but there is no reason why uniformity cannot be carried out on a number of ships or torpedo boats which are built at about the same time. The new navy is to a great extent experimental and this appears to offer an additional reason why new designs should be tried in such a way as to bring out the results of several applications of the same thing. Evidently an attempt was made to carry out this idea in ships Nos. 5 and 6, and also in Nos. 7, 8 and 9, but it was done only partially, and all five of these ships might as well have been from the same designs.

It would be expensive to go deeply into interchangeability, yet the convenience of being able to carry extra parts of machinery is so great, and the saving of delay in making repairs might under certain circumstances be so important that the plan is worthy of careful consideration. The interchangeable feature of the three-throw crank shafts of the battleship *Iowa* is a valuable one. The cranked portion of the shaft is made in three sections, which are so nearly duplicates of each other as to permit of carrying a spare section on the ship, that will fit in place of any section in case of accident. There appears to be no reason why this idea cannot be developed so that a spare shaft would fit in any of a half-dozen or more ships or torpedo vessels. The latter vessels, by the way, are specially liable to suffer breakdowns on account of the high speed of their machinery.

English travelers pay a good price for their privacy in railroad trains and the increasing frequency of outrages in compartment cars has at last brought the matter to the point of investigation by a "Department Committee." Proper means for communication between compartments and between cars are needed and the easiest way out of the difficulty would appear to be the provision of the equivalent of the methods which have found such favor in this country. If privacy must be had why not build compartment cars with corridors and vestibules? From an American standpoint the English roads can hardly introduce a greater improvement than this in their methods of car construction. The wonder is that it was not generally adopted long ago.

The list of horrible accidents which have occurred through the lack of protection of drawbridges over which electric street cars are operated has been lengthened by the running of a car off a bridge abutment at Bay City, Mich., July 7. The dead number eight, and the accident was apparently due to the total lack of signal protection to the bridge. It is stated that the car was racing with a steam train, which makes the case so much the worse, justifying the suggestion that that the first principles of railroading should be applied to street car operation. The public knows all about these disasters and that no action compelling railways in the streets to provide proper protection to such points is most unaccountable. Drawbridges constitute the most dangerous' element in railroading, and even when properly signaled are bad enough, but to leave them absolutely without safeguards must be characterized as criminal before the moral law. The steam railroads are not wholly out of reach of a corresponding charge. Only a few weeks ago a part of a suburban train on one of the leading Western roads ran into a river through an open draw—the only protection provided being an antiquated signboard with the outline of a fish, the position of which is intended to indicate whether or not a passing train will take a dive into the river. This bridge happens to be a difficult one to provide with signals, but the celerity with which the work will be accomplished after a serious accident occurs there will doubtless prove that it can be signaled. It is to be hoped that such a case will not arise, and that precautions will be taken to prevent it. This road has given a great deal of attention to its signaling, but the one place left out may be chosen as the scene of disaster.

Economical use of lubricating oil on locomotives is important to railroads, justifying the attention given to the subject, and one of the railroad clubs has just discussed it in the hope of ascertaining a proper mileage to allow per pint of oil. Any means by which the cost of operation may be reduced is of course important, but this seems to be an item, like the prices paid for piecework, which should not be subject to comparisons among different roads unless they are all working under the same conditions. Nowadays little weight is placed upon comparative records of repairs or fuel when based upon the locomotive mile,

because the work done is not given consideration, and the same should hold true of other factors of expense which are affected by the amount of work done. Comparisons of oil consumption made upon the same road year by year, and based upon tonnage and distance, would appear to be of real value, and such figures might be advantageously compared in a general way with those from other neighboring roads. It does not, however, seem at all necessary that the results obtained by men on road A should be compared with those on road B in order to enlist interest in the subject of economy in the use of oil, and it is probable that the men themselves would place more confidence in comparisons which they could see and understand to be correct and fair. It would, perhaps, be a good plan to enlist the interest of locomotive men in the economy of repairs based upon the ton-mileage made by their engines, and to let the oil records come into the rating of the men in regard to the cost of keeping up the equipment. If this is not done in some way a danger exists in the tendency to save oil without due regard to imperfect lubrication. A cut cylinder would cost more for repairs and loss of time of the engine than would be balanced by the saving of a great deal of oil. The cost of repairs will receive increasing attention during the next few years, and it seems logical to suggest the relation between wear and lubrication as having an important bearing upon the cost of maintenance based on ton mileage.

The use of higher pressure in marine practice is attracting greater attention to nickel steel as a material for boiler construction and the United States Navy experiments are not the only ones devoted to the investigation of the merits of this alloy for boiler work. English engineers have taken the subject up with vigor and with promising results. The water tube boiler has not yet made much progress in marine work outside of naval vessels and there are good reasons for believing that the cylindrical type will continue in favor in merchant ships and in stationary practice. The limit of pressure in cylindrical boilers is fixed by the thickness of the shells of the boilers and with the superior strength of nickel steel the plates can without doubt be made much thinner than the use of ordinary steel would require. The boilers for the United States battleships Nos. 7, 8 and 9 will carry 180 pounds pressure per square inch and the shell plates are nearly one and one half inches thick. It is obvious that large boilers for pressures higher than this must be so heavy as to render these and higher pressures undesirable and nickel steel will be welcomed by designers who have these problems to work out. Mr. Beardmore who recently read a paper upon the subject of this alloy before the Institution of Naval Architects, points out an important property which it poseesses, in that it does not develop cracks as does ordinary steel. The progressive breaking of axles, for instance, so often found in those of ordinary steel, does not seem to occur in nickel steel, and this constitutes an advantage which would appear to render the material specially well adapted to railroad work for tires, axles, piston rods and crank pins. With increased strength, high elastic limit and no sacrifice of ductility a wide field of usefulness seems to open before nickel steel and an extended use of it is expected.

Education is a preparation for the work of life and that education is best which best fits the dupil for meeting the problems which are to confront him when he has no professor at hand to advise and show him how to meet difficulties. Much could be said about best methods of acquiring the ideal education, and there are as many ideals as there are friends of education. The knowledge acquired from books, that absorbed from personal acquaintance with instructors and that obtained inductively from investigation are all important, but there is another factor in education which must not be ignored, that is, the ability to conduct enterprises. There is much to be had from a school course aside from the academic advantages, and as Mr. Wm. S. Aldrich puts it, the highest honor man at college is frequently, in fact, usually, distanced in after life by the all-round man who studies fairly well, and who, at the same time, knows how to dance, to skate, to play football and to make himself agreeable to the young ladies as well as to his fellow-students. Both these men are sometimes surpassed by the man who has never had a college education, for the latter, in his efforts at self-education, never finds a stopping place, while the college man is apt to think himself educated when he receives his diploma. The advantage is with the college man, however, for he is like the man who has taken time to grind his axe before going to the woods, while the other is like the man who starts with a dull axe, and who is lucky, indeed, if he finds time to sharpen it, though he may have cut many trees before the other gets started.

LONG LOCOMOTIVE RUNS.

There is a marked contrast between English and American methods of operating heavy express passenger service in the length of the continuous runs, those of England often reaching 150 miles, whereas in this country there are comparatively few continuous runs of over 60 miles. There were in England last year 55 regular continuous runs of 100 miles or over. The long runs are desirable in many respects, and yet for good reasons we shall probably be obliged to be contented with shorter ones in this country for many years. The lengthening of locomotive runs regardless of the number of stops is, however, a very different matter, and it is possible to extend them to limits which are set by the shortcomings of the fuel used. More attention is now given to this subject than ever before, and as a result we have one locomotive run of 495 miles per day on the Chicago, Burlington & Quincy which consists of doubling a distance of 242.5, and is doubtless in excess of any daily mileage elsewhere.

The reasons for seeking to increase the length of runs are simple. It is advisable for mechanical reasons to keep the boilers in service as constantly as possible, and it is important from a commercial standpoint to get the mileage service from locomotives in a short space of time so as to require only the minimum of investment in equipment. There is a saving to be had from reducing the number of times that the fires are dumped and the number of points at which round-house and terminal forces must be maintained, and the longer the runs the less will be the loss of time by trains in changing engines. The principles which are carried out in marine practice, in which machinery is kept working as continuously as possible, seem to apply equally well in locomotive work, and the reasons are easy to understand. Machinery needs no rest, and if idle longer than time sufficient to properly care for it, a waste occurs.

The discussion of the length of locomotive runs is also productive of good in calling attention to matters with which the actual operation of the engines has nothing to do, such as the unnecessary switching of trains and the changing of cabooses in the case of freight trains, this having been found to be an item of more importance than was realized. It is, perhaps, true that more credit for economical improvement is given to increased length of runs than properly belongs to it, because of the fact that several leaks have been concealed under the changing of engines. It was thought necessary to change engines frequently, and advantage was taken of the stops thus caused in order to do a lot of odd jobs with the trains, such as switching, iceing and watering the cars. The elimination of the changes at various points frequently carries other important advantages in its wake and the result is a decided saving, as it is the sum of direct and incidental improvements.

It is necessary to be temperate in estimating the value of any such improvement, exaggeration of which is likely to mislead, and a very excellent opportunity is offered, by the suggestion of a change in practice, to look over previous practice to see that all the available good results have been squeezed out of the old before adopting the new. Many of the incidental advantages attending long runs ought to be enjoyed any way, even if the longer runs were not made a consideration. It is stated, for instance, that great savings may be made by reducing the number of yard masters, switch engineers, train despatchers and other similar employees, owing to the reduction of the number of locomotive terminals. The system is wrong if the changed locomotive runs leads to any such reduction. It is held by a contemporary that an improvement of about 25 per cent. may be expected from the institution

of long runs. This is believed to be unreasonably high. The saving in coal may be a measurable item, and it may not because of the difficulty introduced by the dirty fires which are incident to long continued running. Nothing will be saved in the wages of engine crews unless the previous runs were too short to give the men the daily allowance of mileage. The actual engine mileage may not be increased by the change, but it is clearly possible to increase this factor by turning engines about over short runs. There will, however, always be a saving in the terminal expenses for such help as wipers and hostlers. The plan is evidently good and without doubt will be the means of effecting a great saving, but an improvement amounting to 25 per cent. is not to be expected except where something is radically wrong with the old methods. There are obvious advantages in long runs aside from the possible increase in mileage, but large mileage is to be sought for even if special conditions prevent the changing of locomotive terminals and the extending of runs.

RAILROAD TESTING BUREAUS.

The advisability of establishing testing stations supported by the railroads was suggested at the recent Master Car Builders' convention, and that of installing routine and research laboratories under the control of the Master Mechanics' Association was mentioned at the convention of that association. The subject of railroad testing laboratories has been a favorite one with the associations for nearly twenty-five years, and in 1874 at the Chicago convention of the Master Mechanics' Association, a committee reported upon a general laboratory scheme, and after a discussion which now seems amusing, the matter was laid over until the following year, when it was dropped because a majority of the members opposed drawing from the funds of the association for such a purpose. It was a good thing to drop, because it embraced a scheme for a traveling laboratory fitted up in a car for convenience in serving the interests of roads in different parts of the country. Since that discussion was held so many new features of railroad engineering practice have appeared that it seems altogether advisable that the side of the question referring to a research laboratory should be revived.

The most successful roads are now nearly all equipped with laboratories, and that these features of railroad organization have not been cut off during times of business depression is good ground for maintaining that they are now accepted as necessary to business-like management. Many of the small roads cannot afford to establish and maintain laboratories of their own, and it was partly in the interest of these that the subject of testing bureaus was introduced at Old Point Comfort.

Laboratory work is divided into two distinct parts, the routine work of checking up specifications by ordinary tests and the pursuit of original research. It would be comparatively easy, if it is advisable or necessary, for the two associations to combine in a scheme looking to the establishment of a number of testing stations in large railroad centers, to which samples of material could be sent by roads represented, the expense perhaps to be defrayed by charges for work actually performed for each road. It would seem perfectly natural and logical to go a step further and establish a general testing station for the conduct of more elaborate work in the line of research. The expense of a well-appointed dynamometer car or of a stationary locomotive testing plant is too much for more than a few of the strongest roads, and the cost of operating either of these is so heavy that only one or two roads can see their way clear to undertake exhaustive tests thereon. The fact that the Master Car Builders' Association has more money in its treasury than it knows what to do with, and that the other association might easily be in the same condition financially, is suggestive of a possible way of providing for the expense of a joint research laboratory, and the railroads should assist in such a matter.

The advisability of establishing laboratories for routine work by these organizations is however open to question. In the first place, it should be asked whether they are needed. The large roads are equipped with testing machines, and it is doubtful whether those not having them would furnish enough work to permit of paying expenses under a plan such as has been suggested. While such concerns as the Pittsburgh Testing Laboratory offer satisfactory facilities for testing materials used by the railroads, it seems unnecessary for the associations to undertake to equip and operate ordinary laboratories. Good and complete equipment should be employed, which ought to include chemical as well as physical apparatus and the necessary attendance for both. This would be expensive, it would not be needed by all the roads, and it would seem as if the associations would put themselves out of their element to undertake the operation of such plants.

There are no reasonable objections which can be thought of by the writer to a scheme for founding a general research laboratory for such work as is now done by the railroads with which the chairmen of the various committees happen to be connected, and it would appear to be a matter upon which joint action of the two organizations might properly be taken. It is manifestly unfair to expect any railroad to volunteer to shoulder the expense of an elaborate series of tests such, for instance, as are required in investigatons requiring the use of a stationary testing plant, especially when the competitors of the road having the plant are to get equal benefits. While some roads are sufficiently magnanimous to offer the use of equipment and men for the benefit of the associations, this should not be expected. If a committee reports recommendations with regard to the best arrangements for exhaust nozzles and other front end attachments, and a number of roads try the plan and save some 10 or 20 per cent. or even more than that in the fuel consumed by locomotives as was done last year, why should not these roads contribute to the cost of the tests?

As already stated, this idea is not by any means new, but it is more appropriate now than ever before, because with the advances which have been made in methods of conducting investigations, the expense has increased and so also, in a corresponding ratio, have the results of research become more valuable. It was clearly shown at the last conventions that the most important reports are those which are based upon service tests and a suggestion of a general thoroughly equipped laboratory better than any one railroad can afford to establish seems to be a proper one. Such a laboratory could be placed at the disposal of committees and would give them opportunities which are not now available. One of the reports of the last Master Mechanics' convention closes with the following paragraph, which indicates the opinion of that committee upon the subject of exhaustive tests:

> While the results obtained from these tests are very interesting, and may be said to be conclusive for a locomotive of the type used and under the conditions under which the tests were made, your committee feels that sufficient information has not been secured to enable them to answer conclusively the question propounded, and believes that to do so will necessitate making a series of tests with the different types of engines for which the information is desired under different conditions as to gage of track, degrees of curvature, etc., and if the association feels that it is desirable to pursue this investigation further, that it would be advisable to set aside a sufficient amount of money to defray the expenses of making such tests, as the expense incident to making such elaborate tests will be considerable, and it would not be right to expect any railroad company to make them at its own expense.

NOTES.

The recent extension of the Liverpool Overhead Railway and the increased size and service of trains have necessitated an enlargement of the power-station plant, and two additional boilers, engines and dynamos have been installed.

The next road which will probably consider the use of electric traction for surburban service is the Boston & Albany, and the Newton circuit line will present a favorable opportunity for such a change when the work of grade crossing elimination is completed.

In discussing the application of electric motors in machine shops before the American Society of Mechanical Engineers at the Hartford meeting, Mr. W. B. Smith Whaley said that in two cotton mills containing the same amount of machinery, one driven by shafting and the other by electricity, the former required 530 and the latter 450 horse-power to drive them.

A new ship law has been passed by the Russians which makes it necessary for all trade between all Russian ports of the Baltic and the Black Sea and the Pacific coast by sea to be carried on in Russian ships, and under the Russian flag. The new law goes into effect in 1900.

The preliminary trial of the torpedo boat *Dupont* was made July 7, at Newport, R. I. Under a steam-pressure of 225 pounds on three boilers and with 420 revolutions per minute of the engines a speed of 30.83 knots was recorded. The official trial is expected to show much higher speed.

In one of the discussions at the recent meetings of the American Society of Mechanical Engineers the statement was made by Mr. A. C. Woodward that it would cost no more to equip a new shop with electric motors for driving the machinery than it would for the shafting and accessories usually employed.

The steam yacht *Ellide* in her second speed trial over a measured course is reported to have made a mile in one minute and thirty-eight seconds, which is at the rate of thirty-six and one-half miles per hour or within a mile and a quarter of the speed attained by the *Turbinia*. The *Ellide* is only 80 feet long, and the high speed is a result of special designs of hull, boilers and machinery.

In the annual report of the Southern Pacific Company recently published are some interesting figures as to the result of creosoting lumber. Figures are given of the diminished cost of maintaining timber trestles since they have been renewed with creosoted lumber and ballasted floors. In 1891, when the effect of these renewals had become apparent, the cost of maintaining the timber trestles on the Atlantic properties was $1.212 per lineal foot. This fell to $0.953 in 1893, and in 1896 it had fallen to $0.346.

Professor Sweet's idea of a good basement floor for a machine shop, on damp but solid ground, as expressed at the recent meeting of the American Society of Mechanical Engineers, is a layer or two of thin flat stone, bedded in concrete, and then a thin coating of concrete, to give the total depth of 6 inches, a coat of asphalt to keep out the moisture and a layer of 2-inch plank, covered by a top flooring of ⅞-inch stuff 5½ inches or less in width, cut into 4-feet lengths to facilitate repairing, breaking joints with every course.

Encouraging employees to make efforts to perform their duties properly undoubtedly pays, and the marked success of premiums in street railway service in New York is interesting. President Vreeland, of the Metropolitan Street Railway Company, of the city mentioned, states that more than 200 men are now receiving an extra compensation of 25 cents per day because of no complaints having been made against them by officers or patrons of the company for a year past. The number is stated to be growing.

Compressed air has been applied to the pumping of water in England in a new way, recently described in *Engineering*. The power is supplied by a gas engine, which drives an air compressor, the discharge of which is led alternately to two closed vessels. During the time that the air is being forced into one of them, the other is being filled with water, which is in turn forced out by changing over the flow of the compressed air. The change is made automatically. The capacity of the plant, which is at Haverhill, Suffolk, is 18,000 gallons per hour from the wells into the settling tanks, and 10,000 gallons per hour into the high-service reservoir.

In commenting upon the representative ship sent by the United States to the recent naval review, in connection with the Diamond Jubilee celebration, *The Engineer* says: "The *Brooklyn* focused the gaze of each observer present. Our engraving, which is taken at an excellent angle for showing her idiosyncracies, illustrates the appearance of her three huge funnels, and diminutive fighting towers, also her great freeboard forward, and the 'tumble-home' of the sides at the waist. The scattered gun positions stand out boldly; but their proximity to one another on the broadside would seem to indicate a possible danger of the fire of adjoining guns fouling one another. At the same time it was felt by many experts that she would be an awkward enemy to tackle, and that she could give and receive many a hard knock."

In *Le Genie Civil*, May 1, 1897, J. De Rey Pailhade proposes a new division of the day on the decimal system. He divides the day into 100 parts, and each of these into 100 other parts, calling the unit the cé, and consequently the other divisions decicés, centicés millicés, dimicés, etc. The equivalence to the present system is shown as follows:

1 cé		14	minutes,	21.0	seconds.
10 "	2 hours	24	"	00.0	"
1 centicé		0	"	8.6	"
5 "		0	"	43.2	"
10 "		1	"	26.4	"
25 "		3	"	36.0	"
50 "		7	"	12.0	"
1 millicé				0.864	"
1 second				1.157	millicés.
1 minute				69.444	"

The Seaboard Air Line is engaged upon a novel and sensible scheme for promoting the development of agricultural interests along its lines, which consists of a train carrying an exhibit of agricultural implements and machinery for the purpose of instructing farmers in methods of improving their condition. The machinery is accompanied by representatives of the manufacturers, and considerable attention is given to the matter of good road construction. The smaller details, such as fruit drying and dairy operations, are given a good share of attention with a view of making the country as productive as possible. The party includes a representative of the Agricultural Department of the United States, and is under the direction of Mr. John T. Patrick, Chief Industrial Agent of the Seaboard Air Line, whose office is at Pine Bluff, N. C.

The rapid transformation of the White Star liner *Teutonic* into a cruiser for the recent Diamond Jubilee celebration at Spithead has attracted wide attention. Thirty hours saw the change completed under supervision of a British naval officer. The machinists and carpenters of the White Star line were put to work transforming the *Teutonic* into an armed cruiser the moment she arrived at Liverpool on her voyage from New York. Her decks, where the guns were mounted, were sheathed with 4-inch teak, and a lot of stanchions were set up between the spar deck and the saloon deck to strengthen the latter deck. The rails of the ship were pierced to give some of the 16 4.7-inch rapid-fire guns a chance to play. Two of these guns were mounted on the forecastle head and two on the after turtleback. The others were placed in various parts of the ship. Eight four-barrelled 1-inch Nordenfelds were mounted on the saloon deck.

According to the official report of the Minister of Commerce for Hungary on the operating roads in that country there were in 1894 18 roads having a total length of 108,157 miles. In 1895 there were 19 roads operating having a total length of 110,275 miles, divided into:

Animal traction	59,776	miles.
Locomotive traction	34,143	"
Electric traction	16,355	"

Equipment:	1894.	1895.
Horses	1,751	1,763
Locomotives	24	21
Cableway engines fixed	2	2
Cars run by electric motor	92	98
Passenger cars	542	542
Freight cars	101	101

The Budapest electric roads gave the most satisfactory financial returns, 13.64 per cent. in 1895 and 7.11 per cent. in 1894 of the capital invested. The mean earning was 9.15 per cent. in 1895 as against 6.46 in 1894. Four new lines were under construction in 1894, all electric, of which two were located at Budapest.

The scheme favorably reported upon recently by a special commission to the Dutch government, contemplates the drainage and reclamation of the land now covered by the Zuider Zee which is upward of 1,500 square miles in extent. The means proposed to

accomplish the purpose are simple, and consist in the construction of a dam or dyke across the middle of the Zee, and ultimately joining the peninsula near the island of Urk, in North Holland, to Kempen, in Friesland. The completion of this dyke, which would be about 100 feet wide at the base by 20 feet in height, would convert the Zuider Zee into a lake, from which the water would be pumped. The construction of the dyke would take nine years, while the entire work of reclamation would occupy a generation. The estimate of the commission is that the entire work can be executed for the sum of 130 million dollars, while the value of the land to be recovered is assessed at 135 millions.

Hydraulic forging is continually making friends among steel and iron workers. Recently President Martin, of the Iron and Steel Institute (England), commented upon the advantages offered by the press over the hammer. He said in effect:

The press treats the material to be forged, especially steel, in the best possible way, the mass even to the center being worked and kneaded by it. Recently, at Dowlais, a very disagreeable reminder was had of what the interior condition of large masses of iron may be. The shaft of one of the drums at the Bedlinog Colliery, having a length of 27 feet between the bearings and 1 foot 9 inches in diameter, broke after working 18 years. On examination the interior showed that the scrap iron from which it had been built up had practically never been welded in the center—whether it was due to its not having been properly heated, or to perhaps too light a hammer having been used in its forging, could not be determined; but the portions of the fracture showed that the iron forming the interior of the mass had never been either properly worked or welded.

Coke is extensively used in German stationary steam plants as is shown by a paragraph in the *Foreign Abstracts* of the Institution of Civil Engineers. According to the report of a Prussian Royal Commission on Smoke-Consuming Appliances, none of the systems they examined gave perfect smokeless combustion of coal. Where smoke is objectionable, coke is used. The coke consumption on the Prussian railways increased from 24,940 tons in the year 1844 to 182,000 tons in 1858. The high price and irregular supply of coke led to the use of a mixture of coal and coke, and consequently, in the years following 1858, the coke consumption steadily decreased, until, in the official year 1894-5 only 65,250 tons were used on the Prussian railways. Its consumption in stationary boilers has, however, increased rapidly of recent years; 7,900,000 tons being the total consumption throughout Germany during 1894, an increase of 11.1 per cent. over that for the preceding year.

The Philadelphia Fire Underwriters' Association has decided to grant permission for the use of acetylene gas in liquefied form under pressure for lighting purposes, provided that the pressure of gas on the piping in the building to be assured shall at no time exceed one-quarter pound per square inch, and that the cylinder containing the liquefied gas under pressure and all-pressure reducing and safety devices be located outside of such building, and in a separate building well ventilated to the outer air, but of sufficient strength to protect the apparatus from outside interference and from the weather (especially the sun's rays); and that the supply pipe for the building be provided with a hand valve just inside of the building assured, so that the gas may be entirely shut off from such building. It is also provided that the cylinder containing the liquefied gas under pressure shall be equipped with a safety valve to protect against both excessive pressure and unusual increase of temperature, and that both the pressure-reducing and the safety (mercury) valves shall be provided with vent pipes opening into the outer air; and that no acetylene gas or calcium carbide shall be stored on the premises.—*Journal Franklin Institute.*

Recent occurrences in Europe have brought out very clearly the growing use of electricity in warfare. According to *The Electrical Engineer* naval experts at Kiel have been testing the practical uses of dragon-shaped airships or balloons, which may be put on board vessels for use during naval engagements and in reconnoitering. Some of the balloons rose 5,500 feet, remaining fastened to the decks of torpedo boats, which were steaming 18 knots an hour, enabling the balloonists to make valuable observations of the stations of vessels at a great distance. The observations made were communicated by telegraph or telephone from the balloons to persons on the decks of the vessels below, enabling them to change the course of the latter accordingly. At the recent British jubilee naval review the United States man-of-war *Brooklyn* received great attention, and Mr. Laird Clowes, the naval expert, declared that, as proved by the new ship, England is in the resort to electricity many years behind the United States. That she will remain so is seriously open to question, but credit for our leadership is welcome and must be ascribed to the patient and brilliant work of such men as Lieut. B. A. Fiske, who may be said to be devoting their lives to this subject, in behalf of our navy.

The sea-going qualities of monitors have often been questioned, but that the *Puritan* behaved well on a recent trip from Charleston, S. C., to New York there can be no doubt. Captain Bartlett said in his report of the trip: "By 6 o'clock it was blowing a fresh norteasterly gale, with a heavy sea, and although the ship behaved admirably, rolling easily and rising buoyantly. . . . "As I have already stated, the ship behaved admirably in the heavy sea off Hatteras. Her roll is not quick, and she recovers easily and without straining. As was to be expected, while pitching very little, she takes great quantities of water on board, the waves dashing violently against the turrets and superstructure and throwing spray over the pilot-house and bridges. In my judgment, it would be possible to fight the guns in almost any weather, though not without taking water through the turret ports. In moderate weather she would afford a reasonably steady gun platform, owing to her steadiness and slowness of roll. . . . "To-day I inspected the vessel, and notwithstanding the heavy weather of yesterday, with the exception of slight leaks around the armor shelf, which were in existence when she went into commission, and a very slight leak in the executive officers' state-room at the base of the superstructure, I could find no defects."

No official figures on the consumption of petroleum for fuel have been published since the statement presented in the columns of the *Shipping and Commercial List* on Jan. 17, 1894. Then it was shown that the Ohio and Indiana oil fields had furnished for fuel purposes 7,000,000 barrels crude in 1890, a trifle over 9,500,000 in 1891, about 11,000,000 in 1892, and 9,000,000 in 1893. The consumption dropped to 8,000,000 barrels in 1894, and last year the total sales of fuel were 7,600,000 barrels. Since Jan. 1 the movement of crude for that purpose has continued at about the same ratio. The decline is owing to reduced production and higher prices. In 1892, when consumption was at its highest point, and producers were pushing the use of oil for fuel, the cost of Lima oil at the wells was 15 cents per barrel, in comparison with 72 cents as the average last year. The decreased yield of Pennsylvania crude compelled refiners to give more consideration to the so-called Lima oil. By improved processes they brought the Ohio refined to perfection, and it is now as acceptable for export as any other grade of petroleum. For that reason much less crude is used for fuel, and unless production should largely increase, the volume of business in fuel oil will continue to decrease, so far as the Ohio and Indiana fields are concerned. A different story comes from California, where the production last year was 800,000 barrels, against 400,000 in 1894, half of which was used for fuel and the balance refined. Developments are rapidly increasing the oil wealth of that State, and until the oil is otherwise used great efforts are being made to push it forward as a fuel. It is now being used in locomotives with success, this feature being taken from Russia. The comparatively new fuel is meeting with favor on the Pacific coast, as it cheapens the cost materially to many industries.—*Scientific American.*

Consul Read writes from Tientsin, China, April 17, 1897: "A few days ago the Imperial Railway opened for traffic another 40 miles of railroad beyond Shan-hai-Kwan, along the Liaotung Gulf, in the direction of Kin Chou. The terminus of these 40 miles just opened is at Chung-hou-so, on the Lu Chou Ho. The total length of the railway from Tientsin to Chung-hou-so is nearly 214 miles. The line from Tientsin to Peking is within a few miles of Peking and will be opened to the public shortly. The Tientsin-Peking extension will add another 80 miles to the present 214 miles in operation. Mr. Kinder informed me that the survey of the Peking-Paoting-fu extension had been completed, and that the throwing up of embankments would soon be begun. This Peking-Paoting-fu extension will add another 80 miles to the system."

The refuse destructor plant at Shoreditch, England, was opened June 28, by Lord Kelvin. The works were established by the municipality and are designed to destroy the local refuse, generate electric light, and supply hot water to the public baths and laundries. Carts will convey the street, trade and household refuse to the works, where motor cars and electric hoists will distribute it to tipping platforms. Hence it will be shot by the aid of mechanical feeders into a dozen cells of the destructor. A forced draught is provided by motor-driven fans, some of which will exhaust an adjacent sewer and blow the gases therefrom into the furnace to help feed the flame. Steam generators and boilers will be used to drive the engines and dynamos and to heat the water to be furnished to the baths and laundries. It is expected that 20,000 tons of refuse a year, which has formerly been carried out to sea at great expense, will be consumed annually in this plant. Lord Kelvin, in opening the works, described the project as an extremely happy union of scientific knowledge and mechanical skill, and said that it required remarkable courage in its application in this initial plant.

The water-tube boiler was endorsed in a paper by Rear Admiral Fitzgerald recently read before the Institution of Naval Architects. The Bellevile boiler was the type upon which the observations were based and the experience was obtained on the *Powerful* and *Terrible* as well as on several smaller vessels. These boilers possessed marked advantages in point of rapid steam raising, ability to make large and rapid increases of speed and correspondingly rapid decrease without blowing off at the safety valves, comparative safety, facility for examination, cleaning and repairs, and saving of weight. As to the rapidity of steam raising, the *Sharpshooter*, a 735-ton gunboat raised steam in 20 minutes from cold water and "fires out"; with the old form of boilers the time required would have been from two to three hours. The rapidity of increasing the power enables a large ship to be started off nearly as quickly as a small torpedo-boat. The safety from explosion is greater because while one of the boilers of the *Powerful* holds a ton of water, each of the boilers of the *Majestic* holds 22 tons. The water-tube boiler is rendered accessible because it may be quickly cooled without injury to seams and plates. An idea of the saving in weight may be obtained by comparing the weight of the boilers and uptakes of the *Powerful* at 1,164 tons with that required for Scotch boilers, which, for the same power, would weigh 1,862 tons, a saving of nearly 40 per cent. for the water-tube boiler. These comments are from the standpoint of a naval officer who has to fight the ship.

Fast Run on the New York Central.

A trip made by train No. 51, the Empire State Express, on the New York Central & Hudson River Railroad, July 16, deserves to be chronicled among the great achievements in the direction of fast running. The time for the distance has been surpassed, but in this case absolutely no preparation was made for extra fast time and the work was done by the locomotive runner in an effort to make up lost time and bring his train to its destination on time. The run was between Syracuse and Buffalo, the train having been delayed so as to be 23 minutes late at the former station. Twenty-one minutes were made up in the run of 149 miles and the train was only two minutes late at Buffalo, the time for the distance, stops and slow downs not deducted, being 143 minutes or an average speed of 62.6 miles per hour.

The train consisted of a cafe car, two coaches and a drawing-room car weighing together 374,000 pounds not including passengers and baggage. The engine was No. 903, built in 1892 by the Schenectady Locomotive Works to designs and specifications by Mr. Wm. Buchanan, Superintendent of Motive Power and Rolling Stock of the road. The engine is of the eight-wheel type, burning bituminous coal. The cylinders are 19 by 24 inches, the drivers are 78 inches in diameter, and the weights are as follows: On drivers, 81,400 pounds; on truck, 44,750 pounds; total, 126,150 pounds. The total weight of the engine and tender in working order is 200,000 pounds.

It will be interesting to compare this performance, which was not prepared for, with some for which every facility was given for fast work. The highest average speeds for runs of more than 100 miles in the record-breaking trip on the Lake Shore & Michigan Southern in 1895 were 64.25 miles per hour for the Air Line division of 133.1 miles and 62.18 miles per hour for the Toledo division of 107.8 miles, but the recent New York Central run is not reckoned by the time while running only, because of necessity the speed must be taken from the start to the finish without deducting lost time, for the simple reason that there were no timers present and no one knows accurately the exact amount of time which was lost. This run was made in the ordinary course of business and it appears to be a case admirably confirming the belief that marked improvements are being made in the facilities for every-day fast long-distance travel. Encouragement should be offered to roads upon which the men handling the trains take such interest in punctuality.

Some Great Liners.

Apropos of the gigantic Atlantic liner which is under construction for Messrs. Ismay, Imrie & Company, of the White Star Line, at the Queen's Island yard of Messrs. Harland & Wolff, Belfast, it may not be out of place to give a few particulars in regard to the two rivals of the *Oceanic*, which have been building during the past twelve months at the Vulcan Shipyard, Stettin, and at Herr Schichau's, Dantzic, for the North German Lloyd Company, but which are now quite eclipsed by the Irish boat. We have added to our tabular statement of dimensions, etc., a few figures descriptive of the characteristics of the *Great Eastern*, and embodied the whole in a comparative form, which indicates very plainly that the old Leviathan—as she was named at first—has yet to be beaten in point of displacement or actual size.

The beam of the *Oceanic* we have estimated by taking a similar proportion of the length to that which is found in the most recent liners built for the White Star Line. The draught is an arbitrary factor, and has been fixed by us, for the sake of comparing her with the German twin vessels, at 26 feet. The draught of the Great Eastern was ordinarily, we believe, about 2 feet more. The various features are as follows:

	N. G. Lloyd's Liners.	*Oceanic.*	*Great Eastern*
Length between perpendiculars	625 feet	680 feet	680 feet
Length over all	645 "	704 "	697 "
Beam	66 "	72 " (?)	83 "
Draught	26 "	26 "	28 "
Moulded depth	43 "	— "	— "
Displacement	20,500 tons	24,349 tons (?)	32,160 tons
Gross tonnage	13,700 "	17,000 "	22,000 "
Horse-power, indicated	30,000 "	45,000 "	2,700 nom.
Speed	23 knots	27 knots	12 knots
Number of propellers	2	3	1 & padls.
Co-efficient of fineness, estimated	.67	.67 (?)	.71

The co efficient of fineness of the *Oceanic* we have estimated as probably about ·67, for although her speed is to be far higher than that of the German vessels, as a rule co-efficients are rather more bluff in British vessels than in foreigners. It will be noticed that the ratio of beam to length in the *Great Eastern* was far higher than that maintained in modern liners, being $\frac{2}{17}$ instead of $\frac{2}{0}$. The reason of this was because an agitation set in about the year 1851 against the knife-like lines which were becoming characteristic of our ships at that time. It was not unusual then to find vessels proposed with a proportion of beam to length as 1 to 12! It is somewhat singular to find that our shipbuilders are again approaching the ratio of 1 to 10. So far as we know, however, no modern liner has hitherto gone beyond this limit.—*The Engineer.*

Books Received.

MINUTES OF CONVENTION OF EMPLOYEES OF THE BRIDGE AND BUILDING DEPARTMENT, CHICAGO, MILWAUKEE & ST. PAUL RAILWAY. 134 pp., paper, standard size (6 by 9 inches). Chicago, 1897.

This pamphlet records the proceedings of the meeting of a technical organization formed among the assistant engineers, bridge inspectors, district and chief carpenters of the Bridge and Building Department of the Chicago, Milwaukee & St. Paul Railway. This organization was started several years ago for the purpose of enabling the members of the bridge and building staff of the road to study and discuss questions relating to their work. The subjects are presented in the form of brief papers, which are discussed by the members. Among these the following subjects indicate the character of the work done. "Economy," by Onward Bates, Chief of the Department; "Co-operation Among Department Subdivisions," by G. W. Smith; "Water Supply for Locomotive Use at Stations," by H. A. Schumacher: "Construction of Buildings," by J. U. Nettenstrom; "Waterways," by A. G. Baker: "Material of Construction," by W. A. Rogers; "Life of Wooden Bridges," by E. S. Meloy; "Method of Erecting Iron Bridges," by E. Greenwald; "Our Iron Bridges," by A. Reichman; "Notes on Masonry Construction in 1896," by W. A. Rogers, and "Office Work," by W. W. Christie. These subjects are presented by the men who have charge of the various departments represented, and while the treatment is intended to benefit those upon that road, there is much to be learned from the paper by an outsider. The most commendable feature of the publication is the fact that it is a result of the liberality of the management of the road and of the head of the department in providing admirable means for encouraging and instructing the men in charge of the bridge work. There has been no bridge accident upon this railway system in seventeen years, which is a record to be proud of.

TABLES FOR EARTHWORK COMPUTATION. By C. F. Allen, M. Am. Soc. C. E., Associate Professor of Railroad Engineering, Massachusetts Institute of Technology. Cloth; 6 by 9¼ inches; pp. 38. New York: D. Van Nostrand Company. $1.50.

The tables presented in this book were compiled for the use of railroad engineers in the computation of earthwork, the operations being exceedingly laborious and unsatisfactory without diagrams or tables. The table form is much more convenient than diagrams for field use on account of the compactness of the figures and the superior accuracy of the results. Table I. is adapted for rapid computation for sections of any base or slope, and for irregular and regular sections. Results are readily obtained by the use of Table II. that are correct by the "Prismoidal Formula." In Table III. provision is made for very rapidly taking out quantities for level sections when the center heights alone are given: in making preliminary estimates there is need for such a table, and a limited number of the most common bases and slopes are provided for. The preface states that great care has been taken to make the tables strictly accurate, and that no errors are known to exist. The author requests that any errors found shall be brought to his attention. The letterpress, binding and arrangement of the work are good, and the type in the tables is well selected.

TRANSACTIONS OF THE ASSOCIATION OF CIVIL ENGINEERS OF CORNELL UNIVERSITY. Vol. V., 1896-1897. Containing addresses by non-resident lecturers, miscellaneous papers, constitution and list of members of the association. Ithaca, N. Y., June, 1897.

The most noteworthy of its lectures is that which was delivered before before the College of Civil Engineering by Mr. Charles Hansel, M. Am. Soc. C. E., entitled "Progress in Signal Engineering." The address fulfills the promise indicated in the name and is the best of recent discourses upon the subject. The illustrations present a number of important improvements in signaling apparatus.

VOCABULAIRE TECHNIQUE DES CHEMINS DE FER. By Lucien Serraillier. 222 pages. Published by Whittaker & Company, 2 White Hart street, London, and The Macmillan Company, 66 Fifth avenue, New York, 1897. Price, $3.

This is a railway technical vocabulary with French, English and American terms, and at its close are 22 tables for the convenient conversion of the terms of money, measures, weights and temperatures used in the countres mentioned. The book fills a long-felt want, and it is one that many engineers and railroadmen have needed because of the great difficulty found in obtaining translations of technical terms and expressions contained in engineering literature. It will be a Godsend to translators, and it should be found upon the shelves of every engineer who pretends to keep up with foreign practice. The fact that the business of railroading is comparatively modern, and that words have been coined to fit the needs, and that this has been done independently by the various countries has caused the confusion of terms which renders it difficult to understand engineers who write in other languages. The author in his preface suggests the need of international nomenclature which shall give the technical equivalents of these terms in each language, and thus save the time and labor often involved in looking up special text-books for many terms which may occur in foreign literature or in the course of the annually increasing business dealings between home and foreign railroads. He expresses the hope that some understanding will be ultimately arrived at by which a process, operation or appliance shall be known by one name only in each language, so as to avoid the confusion and uncertainty which often arise when various expressions, denoting the same object, are adopted by different railroads in the same country. The general employment of the fundimental ideas embodied in the Car Builder's Dictionary is needed, only it should not be confined to any one brand of the railroad subject. The author has been mindful of this idea in compiling this vocabulary confining himself to French, English and American terms. He has used a number of authorities, of which a list is given at the close of the work. Among them are well known books such as Railway Car Construction, by Vost, and the Car Builders' Dictionary.

A novel method of classification was followed, in which the terms are grouped according to the subject matter. This was preferred to the alphabetical arrangement, because of the convenience obtained by placing the constituent parts of an appliance under the head of the appliance itself, and synonymous terms are bracketed together, thus avoiding what is often a vague or ambiguous translation when terms are arranged alphabetically. This method of grouping also reduces the size of the book by dispensing with one of its two sections of a bilingual dictionary. Mr. Serraillier invites suggestions and criticisms on the work, with a view of improving future editions, and it is hoped that he will be encouraged to coutinue the labor which has been so well begun.

The book is divided into seven sections, viz : "Class of Railroad," "Administration," "Traffic," "Way and Works," "Locomotives and Rolling Stock," general subjects and tables of British and metric measures. The words in each section are grouped according to subjects and sub-subject. For example, "Culvert" is placed under "Masonry and Brick Work," and under the general heading of "Way and Works." As far as possible the parts of any appliance appear immediately under the name of the appliance. The whole book is arranged in double columns with the French at the left, the English and the American terms being at the right of the page. The American terms are distinguished from the English by asterisks, and where terms are common to both countries these are omitted. For example, our "Pedestal" is called "Axle Guard" in England. The word "Pedestal" is marked with an asterisk, and a foot-note is added explaining that this part is called a "Horn Plate" in England, when it refers to locomotives, and "Axle Guard" when it refers to cars.

The arrangement of the terms which was employed may permit consolidating the work, but it would seem possible to facilitate finding the desired terms if an alphabetical order had been followed. The letterpress and binding are excellent, the size of the book (5 by 7½ inches) is convenient and the work throughout is well gotten up. The book is dedicated to John Clarke Hawkshaw, member of the council of the Institution of Civil Engineers.

BLOCK SIGNAL OPERATION. A Practical Manual by William L. Derr, Superintendent Delaware Division of the Erie Railroad. D. Van Nostrand Company, New York. Cloth, $1 50.

THE author gives general descriptions of the different systems of block signaling, discusses the general principles of blocking and the apparatus employed, gives diagrams of blocks and rules for the government of the various systems. An idea of the work may be obtained from the classification of subjects as follows: General principles, block signals, signal lamps, block towers, signal bells, block records, train orders at block stations, blocking at junctions and crossings, manual blocking, controlled manual blocking, automatic blocking, and machine blocking. The only original matter presented in "A Method of Single-Track Blocking" described in connection with manual blocking. This system embodies features to insure the holding at the proper passing sidings of trains to be met by opposing trains. The purpose of the book is to present the latest American and European practice in block signal operation. Under the heading of Automatic Blocking, the author gives brief descriptions of the Union and the Hall systems with rules which are in use on the Pennsylvania, Lake Shore and Illinois Central Railroads. The book is a valuable one for signal engineers by

whom it whom it will be found convenient for reference. It will also be found useful by those who are studying the subject of signaling. It is well printed and bound, and the diagrams while small are clear. It is furnished with an index.

PROFESSIONAL PAPERS OF THE CORPS OF ROYAL ENGINEERS. Vol. XXII., 1896.

This book has been received from the Secretary of the Royal Engineers' Institute, Chatham, England. It contains the following papers: Combined Naval and Military Expeditions, by Vice-Admiral P. H. Colcomb; The Defence of Plevna, by W. V. Herbert; Flat-Bottomed Boats, by Lieut. W. A. Watts-Jones; Notes on Suspension Bridges on the Road from Ilushmir to Gilgit, by Capt. J. E. Capper; The Forces Made Use of in War and Their Proper Application, by Maj. C. B. Mayne; On Bridging Operations with the Chitral Relief Force, Official Reports; Notes on Indents for Pipes and other Stores for Water-Works, by Maj. C. D. Courtney.

AMERICAN JOURNAL OF MATHEMATICS. Vol. XIX., Number 3. July, 1897.

Catalogue of the University of Virginia, Charlottesvile, Va., catalogue for 1896–1897, and announcements for 1897–1898.

Catalogue of Knoxsville College, Knoxville, Tenn., 1896–1897.

McGill University, Montreal. Announcement of the Faculty of Applied Science for the Session of 1897–1898.

Trade Catalogues.

[In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. These are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

WESTINGHOUSE STEAM ENGINES.

This is an attractive 44-page pamphlet describing and illustratthe "Standard" and "Junior" types of Westinghouse engines. The methods of testing the engines are explained and statements as to their economy in operation are given. Among the illustrations are a number showing power stations equipped with these engines.

SWITCHES AND FROGS. Catalogue of the Ramapo Iron Works of Hilburn, Rockland County, New York. 28 pages, illustrated. (Not standard size.)

This catalogue illustrates and describes the product of the switch and frog department of these works and the high class of the appliances is well known. The parts of track equipment shown are well tried and have been found satisfactory, though work will be executed to special designs which may be submitted. Separate catalogues of switch stands, cars or brake shoes are also furnished on application. This pamphlet shows plans of split switches and the stands with tie bars and other attachments therefor. Frogs-yoked, bolted and spring rails are shown and considerable space is given to crossings and slip switches. The latter part of the pamphlet illustrates ground levers, switch rods and equipment for stub switches. Diagrams are presented with directions for ordering switches, frogs and fittings. The letterpress and engravings are good. The frontispiece is a view of the works at Hilburn, N. Y.

CATALOGUE OF THE GOULD COUPLER COMPANY. 1897. Standard size (9 by 12 inches). 76 pages. Bound in leather; illustrated.

This catalogue is enlarged and revised and contains illustrations and descriptions of the new devices which have been introduced by this company for the equipment of cars and locomotives for improving the safety and economical maintenance of rolling stock. This company has recently erected a new steam forge at Depew, N. Y., giving modern and improved facilities for manufacturing its specialties. With the malleable iron and forge works at Depew and the steel works at Anderson Ind., the concern is well equipped for the manufacture of safety devices and the catalogue gives an extended view of the various parts of railroad devices produced.

The works themselves are first illustrated and described and the departments enumerated with a statement of the size of the various buildings. The daily capacity of the works in three important items are as follows: Couplers, 700; vestibules, 20, and platforms, 20. The engravings comprise half-tone reproductions from photographs of the works and of special parts of equipment furnished, such as complete couplers and vestibules, and wax process engravings of the working drawings of many of the devices. The binding, paper and letterpress of the catalogue are excellent, the wax process engravings are good, but some of the half-tone reproductions are disappointing in view of the otherwise very high character of the work.

COMPRESSED AIR AND THE CLAYTON AIR COMPRESSORS. Catalogue of the Clayton Air Compressor Works, Havemeyer Building, New York. Official catalogue No. 9, standard size (6 by 9 inches), paper, 106 pp., illustrated.

This catalogue is the most complete work of the kind which we have received. It contains, in addition to an illustrated description of the features of the Clayton type of air compressor, illustrations and lists of sizes of the standard patterns of compressors, and a descriptive article upon the widening use of compressed air, showing the various applications of this power up to date, together with illustrations and descriptions of compressed air tools and appliances. It also illustrates and explains the Clayton air lift pumping system, which is achieving remarkable results in raising water from wells by means of compressed air. Among the other features of this catalogue will be found valuable data for calculating the loss of pressure due to friction in transmitting air through pipes and the capacity lost by air compressors in operating at various altitudes above the sea level. Air receivers, vacuum pumps, flywheel steam pumps, compresors for carbonic acid gas, compressors for testing under high pressure, etc., are also described. This catalogue is issued for gratuitous distribution and will be forwarded upon application.

The fisherman's paradise is without doubt on the line of the Detroit & Mackinac Railway running from Bay City north along the Lake Huron coast. Its popularity for summer and health resorts is increasing every year among tourists. East Tawas is the door or beginning of the trout streams of northern Michigan, and from here north to Alpena the country is laced with rivers whose waters are of exceptional purity and well stocked with many kinds of fish, such as black bass, rainbow trout, pike and pickerel. Some of the smaller streams are within a short distance from Bay City, and none of them are so far away from Detroit, that they cannot be reached in a few hours of travel. The country along the line is easily accessible to the various streams. A copy of "Do You Fish?" may be had on application to J. D. Hawks, president of the road, Detroit, Mich.

When the New York Central's Empire State Express was first placed in service, one of the chief daily newspapers in London published an article on that event, in which it was stated that the train might possibly run for a few days, but it would be preposterous to suppose that it could be made permanent, as there was "no roadbed in America on which a train could be run at the speed of the Empire State Express for any length of time without shaking the cars all to pieces." After five years of daily evidence that such a train is entirely practicable, our British cousins are now fully convinced of this. It is understood that when the Empire State Express was exhibited in the realistic "biograph" on the stage of the Palace Theater in London the audience showed such enthusiasm as in one case to call the manager of the theater before the curtain, which has happened only twice in the history of the theater. The London *Daily Mail* characterized the exhibition as one of the wonders of the age.

"NOBRAC" is the title of an attractive standard size (3¼ by 6-inch) pamphlet published by The Patterson-Sargent Company, of Cleveland, O.

Its purpose is to set forth the advantage of "Nobrac" carbon paints for the purpose of protecting metallic surfaces, and after giving a statement of the requisites of paints for the purpose stated, it presents a number of quotations from well-known engineers on the subject of protecting metal. The pamphlet is well printed and is worthy of preservation.

"1025 MILES IN 1047 MINUTES."

The remarkable run of the Mayham special train over the Burlington line from Chicago to Denver, Feb. 15, 1897, is described in a little pamphlet published by the C. B., & Q. R. R. The record is put in convenient form for filing, and it is worth sending for.

THE ADIRONDACK MOUNTAINS AND HOW TO REACH THEM, NO. 26 OF THE "FOUR-TRACK SERIES"

This is a 4 by 8-inch folder, which is full of information of a practical kind. It contains an excellent map of this wonderful region

on the reverse of which will be found a list of hotels, boarding-houses, private camps, lakes, etc., plainly and correctly located on the map by marginal references, and which has been carefully corrected to date. The folder will be found an invaluable aid in arranging a trip to the mountains. It is another good production whereby Mr. George H. Daniels, General Passenger Agent of the New York Central, renders it easy to obtain information which travelers and sportsmen need before starting on a trip through the Adirondacks.

An advance copy of a little book entitled, TWO TO FIFTEEN DAYS PLEASURE TOURS, has just been received from Mr. George H. Daniels, General Passenger Agent of the N. Y. C. & H. R. R. R. This is No. 8 of the Four-Track Series of 1897.

It contains information about a series of special reduced rate tours, occupying from 2 to 15 days, arranged for the purpose of meeting the wishes of all classes of travelers, including trips to the Thousand Islands, Montreal, Saratoga, Lake George, the Catskill Mountains, Niagara Falls, Chautauqua, Adirondack Mountains, Berkshire Hills, Richfield Springs, and many other famous resorts. Information concerning these trips is given—distances, time, fares, connections and all other details—with much precision. It contains 12 small route maps, a large colored map of the Adirondack Mountains, another of the lake region of Central New York, and several general maps engraved expressly for this work, and is profusely illustrated with half-tone engravings. A copy of the pamphlet will be sent free, postpaid, to any address in the world, on receipt of two 2-cent stamps, by George H. Daniels, General Passenger Agent, Grand Central Station, New York.

AMERICA'S GREAT RESORTS is the title of another of the Four Track Series, No. 3. All of the leading resorts, both East and West, are represented in this folder, and the rates and time from New York, Buffalo and Niagara Falls, given approximately. It will be found an invaluable aid in arranging the details of a summer trip, and will be supplied upon application to Mr. George H. Daniels, General Passenger Agent of the N. Y. C. & H. R. R.R., with four cents in stamps enclosed.

A standard size (6 by 9 inches) pamphlet of 16 pages has been received from the Pneumatic Engineering Company, of 100 Broadway, New York. This concern is in position to contract for its system of pumping by compressed air, and to furnish pneumatic pumps, hoists and air compressors. It is the sole owner of the patents of Silas W. Tufts, covering a pneumatic system of pumping which is described in the pamphlet. Air-lift pumping is yet new to the engineering world, and its rapid introduction is wonderful, constituting a marked recommendation to those who desire to obtain all of the water that their wells can supply and who desire to concentrate their pumping plants. The users of pumps should investigate this system and obtain copies of the pamphlet. The Halsey pneumatic pump is described and the special advantages claimed for pneumatic pumping are clearly stated.

The Webster Manufacturing Company, whose railroad department is represented by Mr. Chas. F. Pierce, has just published a four-page leaflet illustrating and describing the Webster gas and gasoline engines for railroad pumping stations and other service. Mr. Pierce's address is 1113 Great Northern Building, Chicago.

"A Waste Product and How It is Utilized" is the title of an exceedingly handsome and tasteful little pamphlet issued by the Marsden Company, Drexel Building, Philadelphia, in which corn pith cellulose is described in an interesting manner and the various purposes to which it lends itself are outlined.

The Sterlingworth Railway Supply Company has published a new catalogue of its well-known specialties, which may be had upon application to the offices of the company in New York and Chicago.

Messrs. John Wiley & Sons, of 53 East Tenth Street, New York, announce that a new edition of Circular Catalogue V, containing works on steam engines, boilers, locomotives and steam heating, is ready and that copies may be had upon request.

REVISION OF THE M. C. B. INTERCHANGE RULES. Sstandard size (6 by 9 inch).

This four page leaflet has been compiled by the *Railroad Car Journal*, giving the changes which were made in the rules at the recent convention of the association at Old Point Comfort. The form is convenient for the use of inspectors and others and copies may be had gratis from the publishers.

Personals.

Mr. A. J. Mentor has been appointed Master Mechanic of the Oconee & Western at Dublin, Ga.

Mr. J. Hudson has been appointed Superintendent of the car shops of the Grand Trunk at Port Huron, Mich.

Mr. H. A. Gillis has resigned the position of Master Mechanic of the Norfolk & Western Railroad at Roanoke, Va.

Mr. J. Campbell, Master Mechanic of the Lehigh Valley at Buffalo, has been placed in charge of the car department of the Buffalo Division.

Mr. M. T. Carson, Superintendent of Machinery of the Mobile & Ohio Railway, has removed his headquarters from Jackson' Tenn., to Mobile, Ala.

Mr. Theo. N. Ely, Chief of Motive Power of the Pennsylvania Railroad system, is the recipient of the honorary degree of Master of Arts, which was conferred upon him by Yale University.

Mr. W. S. Hoskins, Chief Clerk in the office of Mr. W. G. Van Vleck, General Manager of the Atlantic system of the Southern Pacific Railway, has been appointed General Manager of the Chattanooga Southern.

Mr. N. Frey, General Foreman of the Burlington & Northern road at La Crosse, Wis., will, until further notice, have charge of all men in the locomotive and car departments. Mr. Frey in all but title succeeds Mr. W. H. Lewis.

Mr. John Dempsey, Master Mechanic of the Central of Georgia at Macon, Ga., has also been placed in charge of the car department at that place, and Mr. S. A. Charpiot, Master Car Builder, has been transferred to the drafting department at Savannah, Ga.

Mr. W. C. Squire, formerly of the editorial staff of the *Railway Age*, is now in the service of the Atchison, Topeka & Santa Fe Railroad as Mechanical Engineer to the mechanical department. Mr. Squire has had a valuable experience in railroad work and is well equipped for his new position.

Mr. Onward Bates, Engineer and Superintendent of Bridges and Buildings of the C., M. & St. P. Ry., has recently had the degree of Civil Engineer conferred upon him by the University of Wisconsin. This title comes to many before they earn it. It comes to Mr. Bates after an extensive, successful and honorable experience.

Mr. Alfred Walter, President of the Delaware, Susquehanna & Schuylkill, and formerly General Manager of the Erie Division of the New York, Lake Erie & Western, was on July 13 chosen President of the Lehigh Valley, to succeed Mr. E. P. Wilbur, resigned. Mr. Walter was General Manager of the Erie from March 1, 1892, to Dec. 1, 1894; and from Aug. 1, 1889, to March 1, 1892, he was General Superintendent of the Baltimore & Ohio lines east of the Ohio River. He was formerly for many years with the Pennsylvania Railroad.

Mr. George Gibbs, who for a number of years has held the position of Mechanical Engineer of the Chicago, Milwaukee & St. Paul Railway, has been appointed to succeed the late Mr. David L. Barnes as Consulting Engineer to the Westinghouse Electric Company and the Baldwin Locomotive Works. Mr. Gibbs has been identified with and has originated many improvements in mechanical and electrical engineering applied to railroads, and is unquestionably better fitted for the important work to which he has been called than any other engineer. Mr. Barnes' successor could not have been more appropriately selected.

Mr. F. M. Whyte has been appointed Mechanical Engineer of the Chicago & North Western Railway, his office being at the West Fortieth street shops in Chicago. At almost the same time that he received this appointment he was elected Secretary of the Western Railway Club. Mr. Whyte is qualified to fill both posi-

tions by a wide and valuable experience in railroad work. He is a graduate of Cornell University and was formerly in the mechanical department of the Baltimore & Ohio Railroad in mechanical engineering work. He was afterward associated with the late David L. Barnes, Consulting Engineer, in Chicago, where he spent several several years in important designing and test work. Among the tests were those of the compound locomotives of the Mexican Central Railway. He assisted Mr. Barnes in the consulting work for the Alley L Railroad in Chicago, and after leaving Mr. Barnes he designed the rolling stock for the Northwestern L in the same city and for some time has conducted a consulting mechanical engineering business there.

Mr. John E. Davidson, Third Vice-President of the Pennsylvania Lines West of Pittsburgh, died at Pittsburgh, Pa., July 11, from the effects of an operation performed July 8 for appendicitis. He was born in Allegheny, Pa., in 1838, and after leaving school entered the service of the Pittsburgh, Fort Wayne & Chicago Railway, as clerk. He remained in the accounting department of that road until he was appointed Auditor of the Indianapolis & St. Louis, at Indianapolis, Ind. He afterward returned to Pittsburgh as Auditor of the Pittsburgh, Cincinnati & St. Louis, and subsequently was made Assistant Comptroller of that road and the Pennsylvania Company. He held this position until 1883, when he was made Treasurer of the same lines, constituting the Pennsylvania lines west of Pittsburgh. April 23, 1891, he was chosen Fourth Vice-President, and in September, 1893, Third Vice-President of the same lines.

Mr. D. W. Caldwell, President of the Lake Shore & Michigan Southern Railway, died at his residence in Cleveland July 21 after a brief illness which until shortly before his death was not thought to be serious. Mr. Caldwell was born in Massachusetts in 1830 and entered the service of the Pennsylvania Railroad as a clerk in 1852. He left that place to become a civil engineer in 1853, and in 1855 was made Superintendent of the Pittsburgh & Connellsville Railroad. In 1859 he was made Superintendent of the Central Ohio Railroad, which place he held ten years until he became General Superintendent of the Columbus, Chicago & Indiana Central Railway. From 1874 to 1882 he was General Manager of several of the Pennsylvania lines. During the last year of the period named he held the title of General Manager of the Pennsylvania Lines West of Pittsburgh. He left the service of the Pennsylvania company in 1882, to become Vice-President of the New York, Chicago & St. Louis, the "Nickel Plate," and after the reorganization of that property became the President of the new company in September, 1887. He held that office until January, 1895. He was elected President of the Lake Shore to succeed the late John Newell in September, 1894. He was also President of the Pittsburgh & Lake Erie at the time of his death.

The resignation of Mr. John F. Wallace, Chief Engineer of the Illinois Central Railroad, is announced to take effect Aug. 1. Mr. Wallace has accepted the office of Vice-President and General Manager of the Mathieson Alkali Works, Providence, R. I. It is a somewhat unusual occurrence for a railroad man, and particularly an engineer of such wide reputation as Mr. Wallace has attained, to leave the field of action in which he has spent so many years and achieved such success in order to take up commercial pursuits. During his six years' service with the Illinois Central Railroad Company, Mr. Wallace has demonstrated that he possesses executive and administrative abilities of the highest order—qualities which in his new position will enable him to manage the large plant which he will have in charge as ably and successfully as he conducted the affairs of the engineering department of the Illinois Central Railroad. Though a young man Mr. Wallace is well known in his profession and throughout the railroad world. When he took charge of the engineering and roadway departments of the Illinois Central Railroad the physical condition of that property was at a very low ebb. He has succeeded in bringing the property up to the first rank among American railroads. All the great improvements that have been made by the Illinois Central Railroad during the past six years have been conceived, designed and executed by Mr. Wallace; and he has made his department of much greater importance and of a more comprehensive scope than is usually the case on American roads. He has been closely associated with the management in all important negotiations, and has assisted in more ways than one in bringing about the improvements that have been made in the property. Mr. Wallace has had charge not only of all new construction work, but also of the physical condition of the entire property, comprising the maintenance of way and structures. Mr. Wallace has occupied a variety of positions in railroad work, starting out in life in 1869 as chainman on a survey. After completing a course in Monmouth College, he in a very short time advanced to the head of his profession. In 1879 he was Chief Engineer of a railroad line from Peoria to Keithsburg, Ill., which he located, constructed, equipped and put in operation. This line was later consolidated with the Central Iowa Railroad. From 1883 to 1886 he had charge of transportation as well as engineering on the latter road between Oskaloosa, Ia., and Peoria.

He has also had a varied experience in the construction of bridges, and during 1887, 1888 and part of 1889 was Resident Engineer in charge of the construction of the Sibley bridge over the Missouri River. From 1889 to 1891 he was Resident Engineer in charge of the construction of a four-track independent joint entrance into the city of Chicago for the Illinois Central and the Atchison, Topeka & Santa Fe railroads. This work cost several million dollars, and besides the ordinary construction, embraced prolonged negotiations with the city of Chicago and other railroad companies and corporations, as well as important bridge construction, interlocking and signal plants, and incidental street improvements. Jan. 1, 1891, Mr. Wallace became connected with the Illinois Central Railroad as Engineer of Construction, during which time he planned and executed the elevation of that company's terminal tracks in the city of Chicago, as well as the other improved transportation facilities for the World's Columbian Exposition business. Besides the great amount of construction work which he has carried out for the Illinois Central Railroad Company, averaging approximately $2,000,000 per annum, Mr. Wallace has also had charge of the Maintenance of Way Department, in which the average expenditure was over $3,000,000 per annum. He is not only well known throughout the country as a railroad man and engineer, but in Chicago he is recognized as one of the most public-spirited and progressive citizens. He is a member of the Union League, Hamilton, Kenwood and Technical clubs of Chicago; was last year President of the Western Society of Engineers, and is this year Vice-President of the American Society of Civil Engineers. It is probable that Mr. David Sloan, Assistant Chief Engineer, will succeed him as Chief Engineer of the Illinois Central.

The Bettendorf I-Beam Bolster.

In the July issue of this journal, page 231, in describing the Bettendorf I-Beam Bolsters, we stated, in speaking of the tests of the body bolsters, that under a load of 130,000 pounds the permanent set was 1.01 inches. We are now informed that the report given us was incorrect, and that the deflection was 1.01 inches, while the permanent set was only 0.79 inch. We are glad to correct this error because the tests were much more favorable to the bolsters than the first statement would indicate.

American Institute Fair.

The recent improvements in applications of methods of traction are to be a feature of the American Institute Fair which is to open September 20 and continue until November 4 at Madison Square Garden, New York City. The Officers of the Board of Managers of the 1897 Fair are Dr. P. H. Murphy, Chairman; Oliver Barratt, Vice-Chairman; Alfred Chasseaud, General Superintendent; George Whitefield, Jr., Secretary, and Allen S. Williams, Chief of the Press Bureau. Everything pertaining to railways or any phase of transportation by land or water is included in the Department of Intercommunication, which comprehends the greatest of all fields

for the genius of the American inventor whose study and experiments have already almost resulted in the annihilation of space and time. The committee in charge of this department—in many respects the most important of all with the American Institute—consists of Mr. Charles Gulden and Mr. S. McCormick.

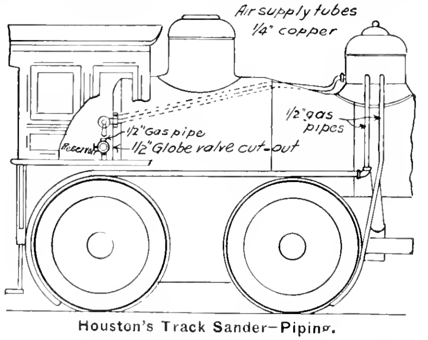
Properly comprehended in the Department of Intercommunication are locomotive engines, cars or models of anything or a part of anything pertaining to the operation or construction of railways. Everything pertaining to road vehicles, which includes motor carriages, models of vessels for navigating the ocean, rivers, lakes and canals of their component parts and of locks, docks, aqueducts or any life-saving apparatus, electric telegraphs, telephones, signals and alarms, implements and contrivances for distributing mails, apparatus for extinguishing fire, and fire escapes, all gas apparatus, implements for expediting trade, locks, safes and hoisting apparatus, articles used especially in hotels and restaurants, devices, apparatus and materials used in the army, navy and the mint and in public edifices and works.

The American Institute has a system of awards for meritorious inventions and improvements which for fairness and value is unsurpassed.

The Houston Track-Sander.

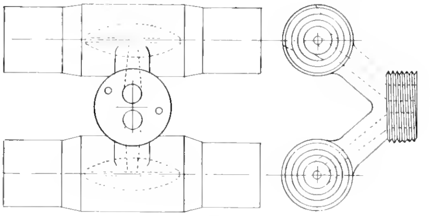
Automatic sanders have become a feature of locomotive equipment, and they are specially necessary in this country, where trains are heavy and stops are frequent. The use of sand is specially necessary with the increased demands of passenger service, and a reliable device for distributing it uniformly is as important in stopping as in starting trains. To effect this result the apparatus must be simple and free from features which may easily get out of order. The accompanying engravings illustrate the plan which is followed in the construction and application of Houston's pneumatic track-sander, which is controlled by the Western Railway Equipment Company, of St. Louis, Mo., of which Mr. E. S. Marshall is Manager.

The essentials of the system consist of a sand siphon and ejector in the sand box, a controlling valve in the cab and the necessary piping. The siphon rests about 1½ inches above the bottom of the sandbox and is enveloped in the sand. The controlling de-

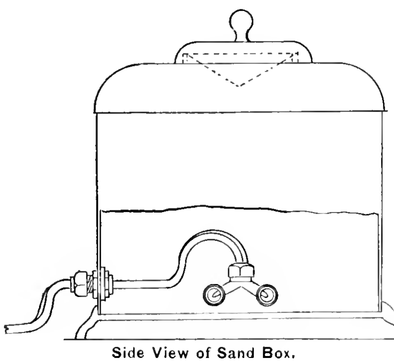


Houston's Track Sander—Piping.

vices are an ordinary ½ inch globe valve and an engineer's valve. The globe valve is used as a cut-out and the other valve graduates the supply of sand upon the rails. This valve has four positions and by it sand may be delivered to the forward tubes only, to the rear tubes only, or to both the forward and rear tubes simultaneously. The last mentioned position of the valve is of service in making emergency stops. Two ¼-inch copper pipes lead from the engineer's valve to the siphons, and from the siphons the sand is carried to the rails through four ½-inch pipes, one pair leading in front of the forward wheels, for use in running ahead, and the other pair leading behind the rear drivers, to be used in backing. Sand flows to the siphon by gravity and it is blown under the wheels by the pressure of the air, the velocity as it emerges from the pipes serving to carry it to the points of contact between the wheels and the rails, even when the locomotive is running rapidly. The piping is simple and easily applied. The control of the sand is reported to be satisfactory, and a list of 33 roads now using the system speaks well for its reception.



Sand Siphon.



Side View of Sand Box.

Nickel Steel.

A paper upon "Nickel Steel as an improved material for boiler shell plates, forgings and other purposes," was read by Mr. W. Beardmore before the Institution of Naval Architects at its recent meeting. He said in the history of iron and steel there had been many alloys which, when first introduced, gave promise of great usefulness, but which on experience ended in disappointment. Quite the reverse had, however, been the case with nickel steel, which had now proved worthy of the confidence placed in it by its supporters. For 12 months he had been continuously engaged in the manufacture of nickel steel for a large variety of purposes, and the results had been eminently satisfactory. He contended that the alloy had many advantages over ordinary mild steel. The *sine qua non* of a structural material was that it should be reliable. They required a metal which could be worked without any special care on the part of the artisan, which was strong and reliable, and would give the same results any time and anywhere. He claimed that nickel steel fulfilled all these conditions, and was the most suitable material to meet the demand for a metal stronger than steel. He suggested that the qualities of nickel were due to the nearness with which the atomic volume approximates to that of iron. In nickel steel they had a metal whose elastic limit was equal to the ultimate strength of ordinary carbon steel, and yet had none of the treacherous brittleness so painfully evident in the latter. It could be punched and bent quite as successfully as ordinary carbon steel, and he had found no difficulty in welding it. It was also worthy of note that the casemates of the Japanese war ship *Fuji* were made of nickel steel, without face hardening by "carburizing," and he was now making nickel steel casemates for the two ships now being constructed on the Tyne. To prove the usefulness of nickel steel when exposed to the action of sea water, he gave details of some experiments at Leith Docks, which proved that the loss in corrosion was less in nickel steel than in either mild steel or wrought iron. The bearing of these experiments on the use of nickel steel for propellers would be evident to any marine engineer. In his opinion, if propellor shafts were made of nickel steel, the question of failure would seldom arise, because a crack in nickel steel would not develop as it would in ordinary carbon steel. In fractures the appearances were different; in the case of carbon steel it was crystalline, but in the nickel it was fibrous. The subject, he concluded, was a most fascinating one. There were

many points on which he would like to have touched—its electrical magnetic properties, for example; but enough had been said to show that nickel steel fulfilled, in a most satisfactory manner, the conditions required of a material for shipbuilding and engineering purposes in an age not characterized by the modesty of its demands.

Convention of the Traveling Engineers.

The Traveling Engineers' Association will hold its annual meeting in Chicago, Sept. 14 next at the Chicago Beach Hotel, where members and their friends will be entertained at the rate of $2.50 per day. The following constitute the committee of arrangements: R. D. Davis, Illinois Central Railroad, Chairman; W. O. Thompson, Lake Shore & Michigan Southern Railway; F. D. Fenn, Crane Manufacturing Company; J. S. Seely, Galena Oil Company; Jas. Fitzmorris, Master Mechanic Union Transit Company, and S. W. McMunn, Old Colony Building, Chicago.

Electricity Versus Shafting in the Machine Shop.*

BY C. H. BENJAMIN.

The ordinary machine shop of to-day, in its shape and size and in the general arrangement of its engines and machinery, is the slave of shafting transmission. The engine must be so located as to connect conveniently with the shafting; all the machines must be arranged in parallel lines, for the same reason; while the ceilings and posts must be designed with special reference to the demands of hangers and brackets. This has been so long the case that perhaps we hardly realize the possibility of a change.

Machinery should be arranged with reference to the work it is to do, and not with reference to the power to be used; it should be so located on the floor of the shop as to be easily accessible for operation and attendance, and in such a way that the work may be readily handled and well lighted.

The whole shop should be planned with a view to handling the product with the least waste of time and labor, and electricity makes this possible. Large machines may be put in any position and at any angle, or, if need be, may be transported from place to place to accommodate the work. The power plant may be located in the most favorable place for taking care of coal, water and ashes, and the power distributed to any building or buildings with but little loss.

In all shops doing heavy work, the rapid and economical handling of the work is one of the most important factors in cheap production.

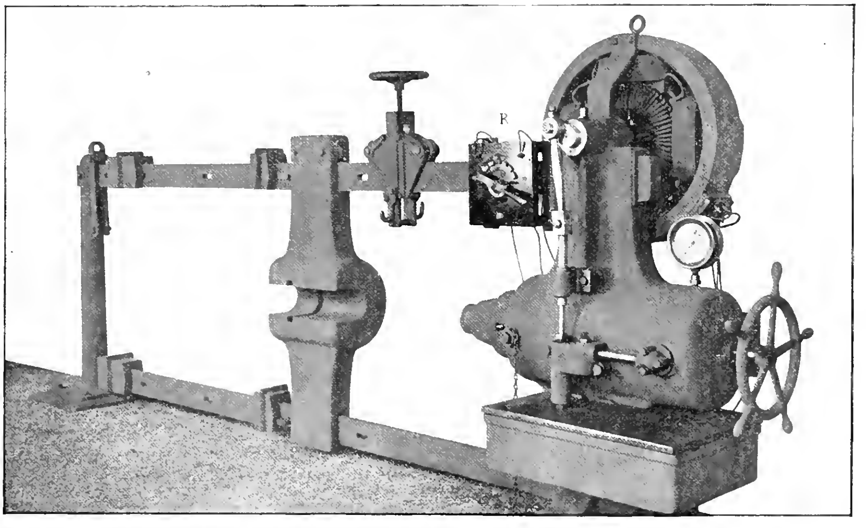
The electric crane is the most convenient and efficient carrier yet developed, and the absence of overhead shafting and belts in electric transmission makes its use possible over all the larger machines.

This advantage of the electric system was what prompted its introduction into the Baldwin Locomotive Works, and the saving there has been notable. Formerly from 30 to 40 laborers were employed to handle the work in the wheel-shop, while now only 8 or 10 are needed; formerly from 8 to 10 per cent. of the time of the skilled help was lost from delays in handling, but this loss has been reduced to less than two per cent. A saving of this kind is of more importance than any probable saving of coal.

As another result of our long subjection to ordinary methods of conveying power, we have come to regard a machine shop as necessarily dark, a synonym for all that is black and dingy. A glance at the shops of some of our electrical establishments will convince anyone that this is a mistake.

Shops like those of the Crocker-Wheeler Company, the Westinghouse Company, etc., have been called "show places"; but at least they *show* the way from darkness into light, and should receive credit for it.

The belt is a dust carrier as well as a power carrier, and nothing can be kept clean in its vicinity. When we add to this the shadows cast by the shafts and belts themselves, we have a condition of things which tends to mistakes and poor work, and cannot be without a corresponding moral effect on the workman.



Electric Motor Applied to a Hydraulic Wheel Press.

The partial or entire absence of overhead belts, and the diffused light reflected from whitewashed ceilings and walls, will cause an improvement in both quantity and quality of output, which will prove a strong argument for electricity.

One of the minor advantages of direct-connected motors on large machines is the possibility of easily and quickly adapting the speed of the machine to the kind of work being done. On large boring mills and lathes, especially when facing up work, this may be a factor of considerable importance in determining the cost of production.

The ease with which the electric system of transmission may be adapted or extended is one of the strongest arguments in its favor. The extravagant consumption of power is probably due, in most cases, to a gradual extension of the shafting system by lengthening shafts beyond a reasonable limit, to the turning of corners with bevel gears, and to the use of turned and twisted belts, with their attendant evils in the way of guide pulleys.

Shops are usually planned with a view to present needs rather

*From paper read before the American Society of Mechanical Engineers, Hartford meeting, 1897.

than future possibilities, and extensions are made at some disadvantage; but in the electrical shop this need cause no uneasiness. Whatever the location or the angular position of the new building, the only expense is that of new motors and a few hundred feet of wire.

If the right kind of an electric system be chosen, the same current can be used in a variety of ways which are just beginning to be appreciated. Besides the advantage of having arc and incandescent lamps without any additional expense for generators, the electric current may be used for welding, brazing, soldering, annealing and case-hardening, and each and all of these operations may be effected locally on large machines without moving them from their positions.

Some are inclined to look askance on electric motors, and to have doubts as to their durability and freedom from accident. To the ordinary manufacturer and superintendent the electric motor is something that he does not fully understand, and, consequently, something to be distrusted.

An electric motor, if properly designed and constructed, requires no more care than any piece of machinery running at the same speed. The writer has had under his personal observation motors which have run for years whenever called on, have required less care than an ordinary loose pulley, and have cost almost nothing for repairs.

Only lately the writer saw a railway motor driving a grinder for pulverizing furnace linings, in an atmosphere so full of grit and dust that the operator had to keep his mouth and nose masked. The motor under a street car will convince the most superficial observer that there is nothing to be feared on this score.

It is difficult to get reliable and precise data from actual examples, even from establishments where both kinds of transmission have been tried; but the most universal testimony of such is that the new experiment is a success, that they would not go back to the old system, and that as rapidly as possible the electric system will be extended to all parts of the works.

When the shops of a manufacturing establishment are scattered over a considerable extent of territory, the installation of a central power plant having large and economical engines, and the distribution of the power to the different shops by wires, instead of by steam pipes, is a change always to be recommended, and that will soon pay for itself.

When the establishment consists of one large building or compact group of buildings, a change to the electric system is to be recommended where heavy work is to be handled, especially if the machines are somewhat scattered, require considerable power, or are intermittent in their action. In such cases some of the shafting may be left in position, but the writer believes that the more independent motors are used on machines requiring over two horse-power the greater will be the economy.

In shops doing light work and having many small machines compactly arranged and in continuous operation, a change to the electric system would be expensive and of doubtful utility.

In building a new shop the chances are better for electric installation, and any manufacturer who does not, under these circumstances, investigate the subject and consider carefully the question of using electricity, is making a great mistake.

The ideal arrangement for a shop handling heavy work is that of a building having one lofty center aisle lighted from above, and two side aisles of less dimensions lighted from the sides. Every square foot of floor space in the central aisle should be commanded by electric cranes. Here the larger tools will be located, each with special reference to convenience in handling work, and, as far as practicable, fitted with independent motors.

The smaller machines are located in the side aisles near the dividing line of columns, and may be driven in groups by short lines of shafting hung on the columns below the tracks of the traveling cranes, each line being driven by a separate motor.

Units of about five horse-power are large enough for this kind of work.

Motors of two or possibly of one horse-power are as small as can at present be economically used.

The benches for hand work should be located at the side walls near the windows. Smaller cranes and electric hoists may command all the space in the side aisles.

Some of the drills and shapes should be fitted with direct connected motors and have eye-bolts at the top by which they may be moved from place to place.

In the power-house the use of two generators, one large and one small, will often prove economical, the smaller one being used for night or overtime work.

EQUIPMENT AND MANUFACTURING NOTES.

The Presidential car scheme inaugurated sometime ago by the *Railroad Car Journal* has fallen flat.

The Union Switch and Signal Company has been awarded the contract for interlocking the tracks of the new South Union Station in Boston.

Wm. Sellers & Company have received an order for a number of injectors for the locomotives which are being built at the Baldwin Works for Japan.

The Secretary of the Navy decided on July 16 to close a contract with the Harlan & Hollingsworth Company for a 340-ton torpedo boat to cost $235,000.

The Chicago, Milwaukee & St. Paul Railway is building 250 stock cars at its West Milwaukee shops. The McCord journal box and lid will be used on these cars.

The works of the W. Dewees Wood Company of McKeesport, Pa., have resumed operations after several weeks of idleness. This refers to mills numbered 6, 7, 8 and 9.

The Rogers Locomotive Company has taken an order for a 12 by 18-inch four-wheel locomotive for the New Jersey & Pennsylvania Concentrating Works of Edison, N. J.

Keasby & Mattison's magnesia lagging will be used on the five locomotives which the Schenectady Locomotive Works are building for the Florida East Coast Railway.

The Dickson Manufacturing Company of Scranton, Pa., has received an order for an 18 by 24-inch passenger engine from the Buffalo, Rochester & Pittsburgh Railroad.

Willard A. Smith, Old Colony Building, Chicago, has taken an order from a Western road to equip 200 freight cars with Bettendorf metal body bolsters and Cloud steel trucks.

The Magnolia Metal Company, of New York, quotes Magnolia Anti-Friction metal 25 cents per pound, No Name metal 18 cents per pound and Mystic metal 8 cents per pound, all f. o. b. New York or Chicago.

The Richmond Locomotive Works has received orders from the Galveston, Houston & Henderson Railroad for two 19-inch switching locomotives; and from the Louisville & Nashville Railroad for ten 21-inch consolidation locomotives.

The National Switch and Signal Co., of Easton, Pa., recently closed a contract for a 20-lever interlocking plant at the East Ottumwa, Ia., crossing of the Chicago, Rock Island & Pacific and the Chicago, Burlington & Quincy Railroads.

Three of the locomotives built by the Pittsburgh Locomotive & Car Works for the Pittsburgh, Bessemer & Lake Erie Railroad have been completed. They weigh about 80 tons each, and are among the largest engines ever turned out at the works.

A stone wall almost a mile in length with an average height of 18 feet, has been built along Second Avenue, in Pittsburgh, by the Baltimore & Ohio Railroad Company. This is a part of the half million dollar improvement that the company is making at that point.

The Ingersoll-Sergeant Drill Company has furnished three duplex cross-compound air compressors to the Atchison, Topeka & Santa Fe. They are fitted with Meyer cut-off valves and with intercoolers and will furnish 600 cubic feet of free air per minute compressed to 100 pounds' pressure.

The Cincinnati, Portsmouth & Virginia has placed an order with the Ohio Falls Car Manufacturing Company, of Jeffersonville, Ind., for 50 flat cars of 60,000 pounds' capacity. These will be equipped with Tower couplers, New York air-brakes, diamond trucks and combination truss brakebeams.

The Richmond Locomotive Works will build two switching engines for the Galveston, Houston & Henderson Railroad, four compounds for the Missouri, Kansas & Texas, ten 21-inch consolidation engines for the Louisville & Nashville Railroad, and 10 locomotives for the Southern Railway.

Pratt & Letchworth, of Buffalo, N. Y., have received an order from the Brooks Locomotive Works to furnish castings for three locomotives for Japan. The company recently made a lot of cast-steel locomotive driving-wheel centers for the same works, which were thoroughly tested, with satisfactory results.

The steel department of the Shickle, Harrison & Howard Iron Company, is reported to be busy, and the capacity of the foundry will soon be increased. One of the furnaces is being completely rebuilt, to add to its capacity, and the construction of a third furnace will be begun as soon as work on the second is finished.

The Pittsburg Testing Laboratory reports a great deal of business on hand, including a number of tests on large steam pumping plants. The necessity for steam users to assure themselves that their plants are economically operated will undoubtedly keep such a well-managed concern busy aside from its other test work.

The Baltimore & Ohio Railroad has just completed on Henderson's Wharf, in Baltimore, a six story tobacco warehouse which has more floor space than any other building in the city. It cost about $150,000, is equipped with all modern machinery for handling tobacco, and has four electric elevators. The building is fireproof and electric lighted.

The Westinghouse Electric and Manufacturing Company has received from the St. Lawrence Construction Company, of New York, a contract for 15 500 horse-power generators for its plant at Massena, in Northern New York. This is said to be the largest single contract for electrical apparatus ever awarded. The amount involved is about $750,000.

The Union Car Company, of Depew, N. Y., has leased the shops of the Schuylkill Navigation Company, at Reading, Pa., for the purpose of building a plant there for the manufacture of chilled car wheels. Mr. R. E. Coleman, General Superintendent of the Depew Works, will have charge of the new plant, which will have a capacity of 400 wheels per day.

The Brooks Locomotive Works have delivered two passenger engines to the Monon. This concern has also received an order for an 18 by 24-inch passenger engine for the Buffalo, Rochester & Pittsburgh Railroad and one from the Great Northern for 16 moguls with 19 by 26-inch cylinders. The Mexican Central has also given them a contract for 20 locomotives.

The Illinois Central Railroad has placed an order with the Rogers Locomotive Company for five, and with the Brooks Locomotive Works for 10, standard 19-inch by 26-inch mogul locomotives. The Illinois Central has also given an order to the Rogers Locomotive Company for four 10-wheel locomotives, and another order for one eight-wheel passenger locomotive to the Brooks Locomotive Works.

The Schenectady Locomotive Works has an order for 10 additional locomotives of the 10-wheel compound freight type for the Northern Pacific. These will be similar to those ordered last month, making 18 new engines of this type. These engines will relieve about 30 moguls now in service, which in turn will relieve about 50 17 by 24 inch engines, and permit of an entirely new distribution of power.

Statements have been received by the *Manufacturer's Record* from different locomotive works, of the country which show that since January last of this year over 100 locomotives, valued at $1,100,000 have been ordered or purchased by railroad companies in the South. The orders include about 90 from standard gage rail roads, and the bal ance distributed among lumber and mining companies which own private railroad lines in the Southern States.

In connection with the armor plate contracts the Philadelphia *Public Ledger* prints a statement to the effect that the Carnegie Company is considering a proposition for the sale of its plant to the Russian government. This report has been in circulation in ordnance circles for some days, and, while the representatives of the companies in New York profess to know nothing about it, some ordnance experts believe there may be some foundation for it.

The National Switch & Signal Company has orders for three interlocking plants for the Chicago & Northwestern; two for the Chicago, Burlington & Quincy; one for the crossing of an electric railway with the Nickel Plate at Painesville, near Cleveland, and one for Pompton Junction on the Erie. This is all new work except the last mentioned contract. The material for the interlocking plant at State Line with the exception of the machine has all been shipped. This machine has a 224 lever frame.

The Baldwin Locomotive Works have received an order for two consolidation engines for the Oregon Improvement Company. These will have Richardson valves, Krupp tires, Paige steel tired wheels, Westinghouse brakes, Nathan lubricators, Monitor injectors, Leach sanders and Utica headlights. These builders have also received an order for six 10-wheel locomotives for the Texas & Pacific, and one for a consolidation locomotive for the Oahu Railroad and Land Company of Hawaii.

The new third-rail electric railway system operated by the New York, New Haven & Hartford Railroad Company is to be further extended by equipping another track in addition to the present single-track line between Berlin and New Britain. It is also intended to extend out to Bristol and Plainville, which are already connected by trolley lines with Hartford. In making these extensions the company has been guided by the excellent results, commercial and otherwise, obtained by the lines in operation.

A correspondent writes from Tientsin, China, to the London and China *Telegraph*, London, May 26, 1897, as follows: "The rail contract fell to Mr. C. D. Jameson, an American civil engineer, who has been for some time resident in Tientsin. His figures were far and away the lowest sent in, and he quoted for Carnegie material. The total value of the two consignments is said to be just under $310,950. As this is the first time American steel has triumphed over European in competition by closed tenders it has attracted much remark."

The Detroit Graphite Manufacturing Company, of Detroit, Mich., has recently acquired the title to the graphite mines in Northern Michigan from which they have been making their Superior Graphite Paint. The ore from this mine produces the best pigment for paint so far found. This pigment is reduced to a fineness never before obtained from graphite, and none of the graphitic carbon is taken from it to be used for other purposes. It is unassailable by acids or chemicals of any kind, and is of an absolute uniform quality. The Superior Graphite Paint made by this company has obtained an enviable popularity.

The Grand Trunk Railway Company has leased its car wheel works at Hamilton, Ontario, to a private corporation made up of the St. Thomas Car Wheel Company and the Montreal Car Wheel Company, and these two companies have entered into a contract with the road to make all the wheels required during the term of the lease. The Hamilton works are to be enlarged, and besides all the car wheels required by the Grand Trunk the new concern will seek outside business, such as the manufacture of wheels for other railroads and for electric car companies. The new arrangement is expected to be more economical for the road.

The double track at Seven Curves, on the Baltimore & Ohio, was opened for traffic at 12:50 p. m., July 1. During the past eight months a large force of men has been engaged in making deep cuts through the hills to straighten one of the worst portions of the road, and the company's officers felt very much gratified on Independence Day when the Chief Engineer announced that the work was completed and ready for the trains. Not only will this improvement prevent a great many derailments and reduce the cost of operation, but it will make riding very much more pleasant over that division. The cost of this work was very nearly $100,000.

The Schenectady Locomotive Works is building three 12-whee or "Mastodon" compound locomotives for the Butte, Anaconda & Pacific Railroad. These engines are the largest of this type ever constructed, the cylinders being 23 inches and 34 inches in diameter with 32 inch stroke; driving wheels 56 inches in diameter; weight of engine in working order, about 189,000 pounds. The boilers are of the extended wagon top, radial stayed type, with about 3,000 square feet of heating surface and will be built to carry 200 pounds working pressure. The engines have cast steel driving wheel centers, and both cast and pressed steel are used very largely in their construction.

The E. P. Allis Company, of Milwaukee, Wis., has just received an order from the Central London Underground Railway, of London, England, for six cross-compound engines of 1,300 horse-power each. They are to be coupled direct to electrical generators, and are of the same type as those used in the Baltimore & Ohio Railroad tunnel in Baltimore, Md. Another order has been taken for four similar engines to go to Sydney, New South Wales, for use on

Government tramways. A 1,600 horse power cross-compound engine has been ordered of this company for the Sagamore Manufacturing Company, Fall River, Mass., to be used for operating the machinery of the entire plant

The Building & Sanitary Inspection Company has just been organized in New York, primarily for the purpose of inspecting and reporting upon the sanitary conditions of buildings and also to superintend the construction of buildings, and to carry on a civil and mechanical engineering business. Aside from the sanitary work, expert tests and reports will be made upon boilers, engines and electric equipment. The inspection of the sanitary condition of railroad stations will be made a specialty. The officers of the company are: President, George Sherman; Vice-President, Wm. C. L. Gendre; Secretary and Treasurer, Thomas H. Robinson; General Manager, Morton E. Davis, and Chief Engineer, Jas. C. Bayles. The headquarters of the concern is at 53 Liberty street, New York.

H. K. Porter & Company, of Pittsburgh, will build the following pneumatic haulage plants for mine service: The Mount Carbon Company, Limited, Powellton, W. Va., consisting of compressor, pipe lines, charging stations, etc., together with one 8 by 14-inch class "B" pneumatic locomotive; one 10½ by 14-inch class "C" motor for the Carbon Coal Company, Greensburg, Pa.; two 7 by 14-inch class "B" motors for the Mill Creek Coal Company, New Boston, Pa. The storage reservoirs on all these motors are designed to carry 700 pounds' pressure per square inch, with the exception of the one for the Cross Creek Coal Company, which is designed for 650 pounds' pressure. In almost every case these orders were secured in direct competition with electric companies who were figuring on the electric equipment.

A patent has been issued jointly recently to Alfred E. Hunt, of Pittsburgh; Benjamin Talbot, of Pencoyd, Pa., and Percival Roberts of Philadelphia, on the use of carbide of silicon in the manufacture of steel. Carbide of silicon is made by passing an electric current through a cove of sand mixed with coke. The finer and better grade is used as an abrasive, but there is produced considerable material which is not valuable for that purpose and can be sold cheaply. It has been used experimentally at Pencoyd. It is split up and gives both silicon and carbon to the molten steel. It quiets and solidifies the metal and may become useful in the manufacture of castings and other specialties when solid metal is desired. It has the advantage over ferro-silicon, with 10 to 12 per cent. of silicon, because the silicon in the carbide is concentrated, the carbide containing about 70 per cent. of silicon and 30 per cent. of carbon.

The Philadelphia & Reading inaugurated its summer passenger schedule on the Atlantic City line July 2 by placing a fast train in service between Philadelphia and Atlantic City. The train is arranged to leave Philadelphia, Chestnut street and South street ferries at 3:40 p. m. Eight minutes are allowed for ferriage and transfer of passengers to cars, and the time table calls for the start to be made from Camden at 3:48 p. m and to arrive in Atlantic City, a distance of 55.5 miles at 4:40 p. m. The first trip of this train on July 2 was a signal success. On this trip there was a delay in the ferriage of 2½ minutes, and it was 3:50½ when the start was made from Camden. Notwithstanding this the train came to a stop in the Atlantic City depot at 4:38½, 1½ minutes ahead of its regular time the distance being covered in 48 minutes. The trip was made under the most unfavorable conditions, the rail was very slippery several miles being run through a very violent thunderstorm, with very heavy winds making it impossible to see more than a half train length ahead, which caused the engineer to slow up, otherwise the running time would have been still less. The train was composed of one regular combination, weight 57,200 pounds; three standard passenger coaches, weight of each 59,200 pounds; one Pullman vestibule parlor car, weight 85,500 pounds, and was drawn by the standard A. C. R.R. engine No. 1027, which is a Baldwin compound engine known as the Atlantic type. This engine has two pairs of driving wheels, 84¼ inches diameter. The high pressure cylinders are 13 inches, and the low pressure, 22 inches diameter, stroke, 26 inches. The firebox is 113⅝ inches long by 96 inches wide. The boiler has 278 tubes 1¾ inches diameter; the total heating surface of the engine is 1,835 square feet. The total weight of locomotive and tender is 220,000 pounds. The total weight of engine and train 647,200 pounds. We are informed that the journal bearings for the engine, passenger and Pullman cars of this train are of the Ajax metal throughout.

Our Directory

OF OFFICIAL CHANGES IN JULY.

Chicago, Peoria & St. Louis.—Mr. C. H. Bosworth has resigned as vice president and General Manager, and has been succeeded by Mr. Henry W. Gays.

Chicago, Burlington & Northern.—Mr. N. Frey has been given charge of the locomotive and car departments, vice Mr. W. H. Lewis.

Chicago, Iowa & Dakota—Mr. H. C. Stuart, General Freight and Passenger Agent, has, in addition, been appointed General Manager of that road, to succeed Mr. William S. Porter, resigned.

Columbus, Sandusky & Hocking.—M. F. Bonzano has been appointed General Agent for the Receiver, with headquarters at Columbus, O. He will represent the Receiver in his absence, and will have direct charge of the traffic and operating departments. Mr. William E. Guerin has resigned as President and General Counsel.

Duluth, Missabe & Northern.—Mr. T. J. McBride has resigned as First Vice-President, but will continue as General Manager of the road.

Delaware, Susquehanna & Schuylkill.—Mr. Alfred Walter has resigned as President to accept the Presidency of the Lehigh Valley.

Forth Worth & Rio Grande.—R. H. Lord, Superintendent of Transportation, having resigned to accept other employment, the office has been abolished and its duties will hereafter be performed by C. H. Stevens, Chief Dispatcher, with office at Fort Worth, Tex. B. G. Plumber has been appointed Master Mechanic, with office at Fort Worth, to succeed H. D. Galbraith, resigned.

Huntington & Broad Top Mountain.—Mr. George F. Gage, General Manager, has resigned.

International & Great Northern.—The title of F. Hufsmith, whose headquarters are at Palestine, Tex., has been changed from Master Mechanic to Superintendent of Motive Power and Rolling Stock.

Kewaunee, Green Bay & Western.—Mr. S. W. Chapman has resigned as General Manager.

Kansas City, Pittsburgh & Gulf.—Mr. Robert Gillham, formerly Acting General Manager and Chief Engineer, has been made General Manager and Chief Engineer.

Lehigh Valley.—Mr. E. P. Wilbur has resigned as President and has been succeeded by Mr. Alfred Walter, formerly President of the Delaware, Susquehanna & Schuylkill.

Norfolk & Western.—Mr. H. A. Gillis has resigned the position of Master Mechanic.

Norfolk, Albemarle & Atlantic.—Mr. James W. Andrews has been appointed Master Mechanic, with headquarters at Brambleton, Va.

Oconee & Western.—Mr. A. J. Mentor has been appointed Master Mechanic at Dublin, Ga.

Santa Fe Pacific.—Mr. W. G. Nevin, General Manager of the Southern California, has also been appointed General Manager of the Santa Fe Pacific.

St. Louis, Chicago & St. Paul.—Mr. Henry W. Gays has been appointed General Manager of the Chicago, Peoria & St. Louis, with headquarters at Springfield, Ill., to succeed Mr. C. H. Bosworth. Mr. Gays retires from the general management of the St. Louis, Chicago & St. Paul.

MASTER CAR BUILDERS' ASSOCIATION.

ABSTRACTS AND SUMMARIES OF REPORTS PRESENTED AT THE THIRTY-FIRST ANNUAL CONVENTION.

(Concluded.)

Improved Freight Car Buffers.

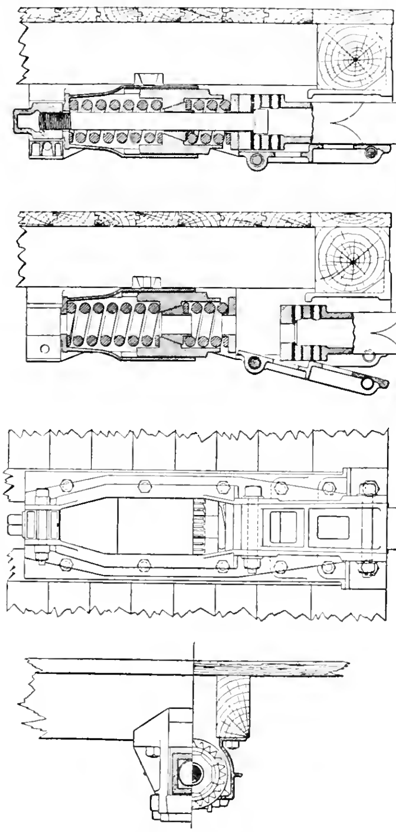
Wm. Forsyth, A. E. Mitchell, F. W. Brazier, Thos. Fildes, John Player, Committee.

Your committee, appointed to follow up and report upon experiments made with improved buffers, has had its attention called to only two improved freight buffers, namely, the Gould spring buffer and the Westinghouse friction buffer.

The Gould buffer consists of two malleable iron cases, each containing helical springs, having a capacity of 12,000 pounds each. The total capacity of the buffer is therefore 24,000 pounds. A number of these buffers have been placed in service on the Lake Shore Railroad, and a few for trial on the Erie and the C., B. & Q. The tests have been simply those for endurance in ordinary service, and the results in that respect have been satisfactory. The cost of cast-iron buffers, M. C. B. pattern, is about $3.60 per car; malleable iron, $4.40. The Gould spring buffers cost $15 per car. The capacity of the Gould buffer, 24,000 pounds, is only sufficient to absorb the work done by a loaded 60,000-pound car, total weight 90,000 pounds, running at a speed of 1.08 miles per hour.

The improved Westinghouse friction draft gear is shown in the accompanying engraving. It has been in service on 50 coke cars for eight or nine months, and has required slight repairs to but few of the cars. The committee witnessed a test of the draft gear on these cars, after eight months' service, on the southwest branch of Penn-

sylvania Railroad. The loaded cars, having a total weight of 58,600 pounds, were thrown together at speeds approximately four to six miles per hour. Under such conditions the motion of compression was 2 to $2\frac{3}{8}$ inches, and the capacity of the draft gear just about absorbed. A shop test of one of these gears was then made under a drop weighing 16,000 pounds, and it was found that a fall of 9 inches just closed it through a motion of 2 inches. In order to get an approximate idea of the pressure required to produce an equal amount of work, a copper disk $2\frac{1}{2}$ inches diameter and $2\frac{1}{2}$ inches high was placed under the same drop and the weight allowed to fall 9 inches. The compression of the copper disk was $\frac{7}{32}$ inch. A similar disk was then placed in a compression testing machine and it required 152,680 pounds to reduce the height $\frac{7}{32}$ inch. This can, therefore, be taken as the total capacity of the Westinghouse draft gear. As the spring resistance is 15,000 pounds, the value of the frictional part of the device is 152,680 — 15,000 = 137,680 pounds. It will be seen that more than nine-tenths of the resistance is by friction. As this is the controlling resistance, and as it acts in both ways, that is, in recoil in either direction as well as in compression, it will be evident that it exercises a braking action upon, and effectually checks the recoil of the springs. This recoil of spring action frequently causes strains to break in two and racks the draft rigging and car framing. To eliminate these destructive forces is the main object of the Westinghouse draft gear. The work done in compressing it, as shown by the drop test, is 16,000

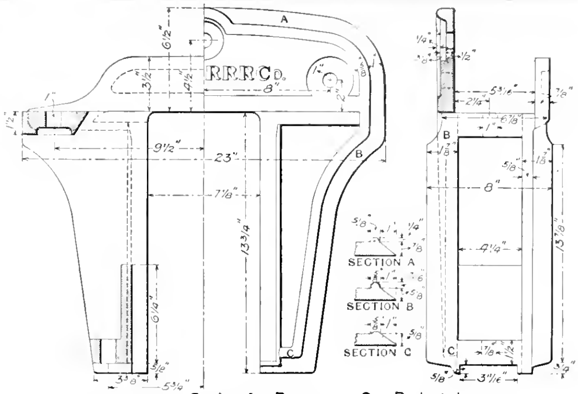


Westinghouse Friction Draft Gear.

pounds × $\frac{3}{4}$ foot = 12,000 foot-pounds. The resistance of the standard draft spring is $\frac{19,000}{2} \times \frac{1}{6}$ foot = 1,583 foot pounds.

$\frac{12,000}{1,583}$ = 7.5, which is the ratio of the resistance of the Westinghouse draft gear to that of the standard draft spring.

This former will, therefore, absorb 7.5 times the shock absorbed by the ordinary draft spring. This draft gear is now being fitted to the 600 steel cars, 100,000 pounds capacity, building for the P. B. & L. E. R. R.



Design for Passenger Car Pedestal.

In the above report we have simply followed our instructions, and have given the results of the experiments made. We have no recommendations to make, and now ask to be discharged.

Passenger Car Pedestal and Journal Box for 4 1-4 by 8-inch Journals.

GEO. W. WEST, T. B. PURVES, JR., E. A. BENSON, T. W. CHAFFEE and J. W. MARDEN, committee.

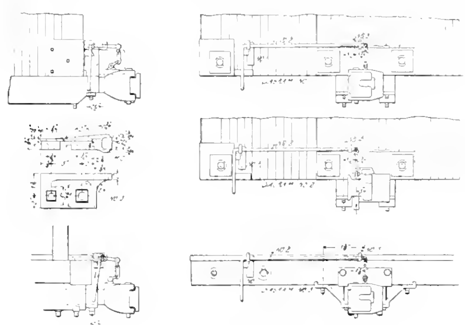
After reproducing the circular of inquiry this report gave a statement of the form which the replies took and concluded as follows:

After careful consideration of the subject, and being governed in a great measure by the replies received, the committee has no hesitation in recommending the adoption of figure No. 2, as shown in circular, for standard passenger car pedestal for journal $4\frac{1}{4}$ x 8, and for passenger car journal box the present inside dimensions of the standard M. C. B. $4\frac{1}{4}$ x 8 freight journal box.

Uncoupling Arrangements for M. C. B. Automatic Couplers.

G. L. Potter, G. W. West, R. C. Blackall, R. M. Galbraith, G. B. Sollers, C. E. Turner, Committee.

Your committee appointed to consider whether a standard uncoupling device is practicable, and the details thereof, submitted a report at the convention held at Saratoga, New York, on June 17, 1896, which report was based on the result of their consideration of the subject with a view to the practicability of submitting a design and location of attachments that could be used with all designs of M. C. B. couplers in use, and concluded that this was not practicable and so reported. After some discustion, during which it was suggested that while it might not be possible to design an attachment in a fixed location that would operate all of the couplers, it was thought possible to design one that would answer for the great majority of the couplers in use, and the committee was continued with



Uncoupling Devices for M. C. B. Couplers.

instructions to further consider the subject and report, which report is herewith submitted.

As the end construction of the foundation of the house cars in use on the various railroads differs materially, in that some designs have the end sills concealed under the siding on the end of the car and use a buffer block outside, which varies in thickness and depth on the cars of different roads, while in other designs the end sill projects beyond the end of the car, performing the additional function of buffer, your committee sent out a letter of inquiry to obtain information as to the variety of practice in the designs of the parts affecting the subject under consideration.

Your committee understands that it is desired that it shall submit designs of as many parts as possible that in their opinion can be

used on all ordinary designs of cars with as many of the different kinds of couplers as possible, and that the parts shall be so designed as to be of sufficient strength to insure the coupler, in the event of its breaking or the giving away of the rear end attachments, being uncoupled and prevented from falling on the track.

There are submitted herewith [not all are reproduced. Editor.] cuts showing a lever, clevis, clevis pin, link and brackets for supporting the rod, which it is believed can be applied to all ordinary cars and be used with any M. C. B. coupler in which the block is located in the top plane of the coupler head and is operated by a vertical movement of the lever arm, to which it is attached. The clevis, clevis pin, link and brackets are shown to be made of malleable iron.

Diagram No. 1 shows the application of the proposed standard parts to a car with concealed end sills with the parts of the dimensions and located as shown on "Plate B, Recommended Practice for Attaching Automatic Couplers to Cars," arranged to operate the lock in a coupler having the lock located on the vertical center line of the coupler.

Diagram No. 2 shows the application to the same design of car with the center of the lock located three inches from the vertical center line of the coupler. Within these limits are located the locks on the great majority of couplers in service.

Diagram No. 3 shows the application to a car having projecting end sills. The bracket supporting the end of the release rod farthest from the coupler is provided with a projection to enable the lock of the coupler to be held in the raised position by pushing the rod toward the center of the car, after being raised, until the outer arm engages the projection, a feature which with many designs of couplers is necessary.

The dimensions of the parts as shown will be suitable for all cars with dead blocks of the dimensions as shown on "Plate B, Recommended Practice," and with end sills 8 or 9 inches in depth; for cars with these parts of different depth the proper adjustment can be made by changing the relation of the arms of the lever to bring the center of the eye of the horizontal arm to the proper height above the eye of the lock or by use of links of different lengths.

There are some designs of M. C. B. couplers in use in which the lock is operated from the side or front beneath. As each type has a distinctive method of operating the lock, your committee did not think it necessary to consider them in this report, although some such types are used in considerable quantities.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

Abstracts and Summaries of Reports Presented at the Thirtieth Annual Convention.

(Concluded.)

Truck Swing Hangers.

G. L. Potter, M. N. Forney, W. Garstang, W. Lavery, John Mackenzie, Committee.

Mr. William Garstang, Superintendent of Motive Power of the C., C., C. & St. L. Ry., made quite elaborate tests with a view to throwing light on this subject. A dynamometer was constructed and attached to the truck axle of a mogul engine, the wheel base and distribution of the weights of which are shown in Fig. 1, and was applied as shown in Fig. 2.

The operation of the mechanism shown on this drawing is as follows:

Flange *A* is loosely fitted to the axle and is kept in its proper position by a feather on the axle.

B is a flange clamped solidly to the axle with a groove cut in the face to receive the ring *C*. To the upper half of this ring is cast flanges *D*, to which is bolted the vernier *E*. To prevent this ring from turning, an arm, *F*, is bolted to each side of the box, on which lugs, cast on the ring, rest. The pointer *G* is pivoted on *E* at *H* and receives its motion from the movement of truck frame through the box *I* and rod *J*. This pointer has a ratio of 4 to 1.

The springs are arranged radially around the axle and were carefully tested on a machine, and a table of pressures compiled for each $\frac{1}{16}$-inch compression.

The boiler vernier *K* is attached to the front of the boiler, and the pointer *L* to the cross-bar of the truck, as shown.

The adjustment of the hanger was done by having blocks *M* fitted to the cross-bars, four for the 6⅝-inch hanger and four for the 8-inch hanger, and slotted radially to suit the length of hanger used. Attached to this block is a plate, *N*, with a series of holes drilled in same, so arranged that the angle of the hanger was changed two degrees by each adjustment.

The hanger pin *O* passes through the clamp *P*, the clamp *P* being slotted for bolt *Q*, and pivoted at *R*. To change the hanger from position shown to the next hole, the bolt *Q* is removed and the pin *O* moved until bolt *Q* can be inserted in the hole required, this being repeated for each change of hanger.

After running through the series of holes mentioned, it was found that the inside holes were giving the best results. Then it was determined to carry the test further until a change was shown, giving an increase of stress. As the construction of the truck was such as to prevent the carrying of the top pin any closer toward the center, the radial arms *S* were made and bolted to the center casting and tests continued until the result desired was obtained, as shown in the tabulated statement.

The tests were made on the Indianapolis Union Railway Company's tracks, where they enter the Big Four tracks at Brightwood, on a three-degree curve with the outer rail raised four inches, which is suitable for a speed of 45 miles per hour. The runs were divided into a series of speeds as follows;

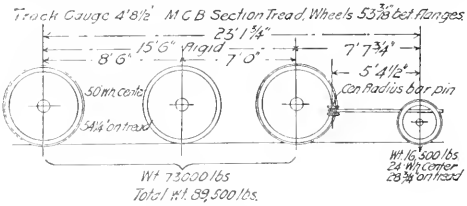
For each angle of hanger and also for a rigid truck; that is, two runs at 18 miles per hour, two runs at 35 miles and two runs at 45 miles per hour, or as near as possible to the above schedule. An average was taken of the runs made with each angle of hanger.

The movement of the pointer *G* was recorded on a card by being connected to a Crosby indicator, *T*, as shown on blue print, and the speed by a Boyer speed recorder, *U*. To insure that all readings were taken at one point, a post was located at the center of the curve, so that it could be readily seen by the operator.

The action of the dynamometer proved contrary to that expected as to its maintaining a constant and uniform pressure after the engine was fully under the influence of the curve. Its apparent action proves that the impact upon entering the curve gave a vibrating action to the springs and, in consequence, to the front end of engine, after which the springs seemed at all times to have been compressed and relieved alternately, which, it is believed, was due to the curve not being a true arc of the circle. The springs, apparently, in addition to this, were compressed to a certain point, and when their combined strength overcame the weight and friction of the wheels on the rails, relieved themselves suddenly and nearly regained their normal set. This gave a line on the card fluctuating from zero to a maximum point, or a resultant stress.

As the vernier is attached to the boiler and the needle to the truck frame, both having a movement in the same direction, the total boiler movement includes the sum of the set shown on the dynamometer and the movement of the boiler vernier past the needle. During these tests, and at random apparently, the results show a peculiar circumstance, namely: Indicators will start and show an increase or decrease in relation to angle of hangers, when the engine will assume a position giving readings nearly fifty per cent. less than would be looked for, this occurring throughout the test, and is, it is thought, due to certain conditions wherein engine assumed a position on track contrary to its general position, or, in other words, hugging the outer rail evenly and smoothly for full length of engine, thereby giving a small truck stress.

The action of the cradle or swing center seemed to be as follows: Hangers which have an angle inside of an inch either way from the vertical, by reason of the small angle, seemed to allow the



Truck Swing Hangers.

boiler to sway to its maximum position and back again to extreme in other direction, this surging tending to raise the stress on truck wheel flange, and speaks for itself in the tabulated results.

Hangers whose angle exceeds this in either direction absorb a part of this sway, and consequently show a reduction of truck stress. The hangers giving the best results, namely, showing the least boiler swing and least stress on the truck-wheel flange, were the hangers whose points of suspension are closer together than the suspending points on the center casting. The length of hangers bears an important relation to stress indicated. For instance, the two lengths of hangers used in these tests, one of which was 8 inches and the other 6⅝ inches long, at the 18-degree angle, suspended as before mentioned, showed results which would indicate that the hanger whose arc is of the shortest radius in a given length of movement, and necessarily has the greatest middle ordinate, tends to raise the engine more abruptly and suddenly, thereby absorbing a greater percentage of stress and reducing the flange stress in a corresponding ratio. This shows to be in favor of the short hanger, but just what length would be the mean was not determined.

To note the position of engine on the curve at the various positions of the boiler, as shown by tabulated statement, a section of the curve was drawn at 3-inch scale and a tracing made of plan of engine and plan of the truck, which showed that the back driver and truck flange bore against the outer rail, while the front flange cleared with the 6⅝-inch hanger at the 18-degree angle, with a boiler movement of ⅝ of an inch. With a boiler movement of ¾ of an inch and over, the front driver flange came in contact with the rail, and with the maximum movement of the boiler as recorded, the back driving wheel flange bore hard against the inside rail of the curve, and the front driving wheel flange and truck flange bore hard against the outside rail, thereby confirming the record of the road tests and our conclusions that the angle of the hanger giving the minimum flange stress with the minimum boiler movement to be the proper angle to use.

The angles giving the best results for the two hangers in this test were 18 degrees for the 6⅝-inch hanger, and 28 degrees for the 8-inch hanger, which leads the committee to believe that the angle of the hanger should be changed for each length of hanger used.

The Apprentice Boy.

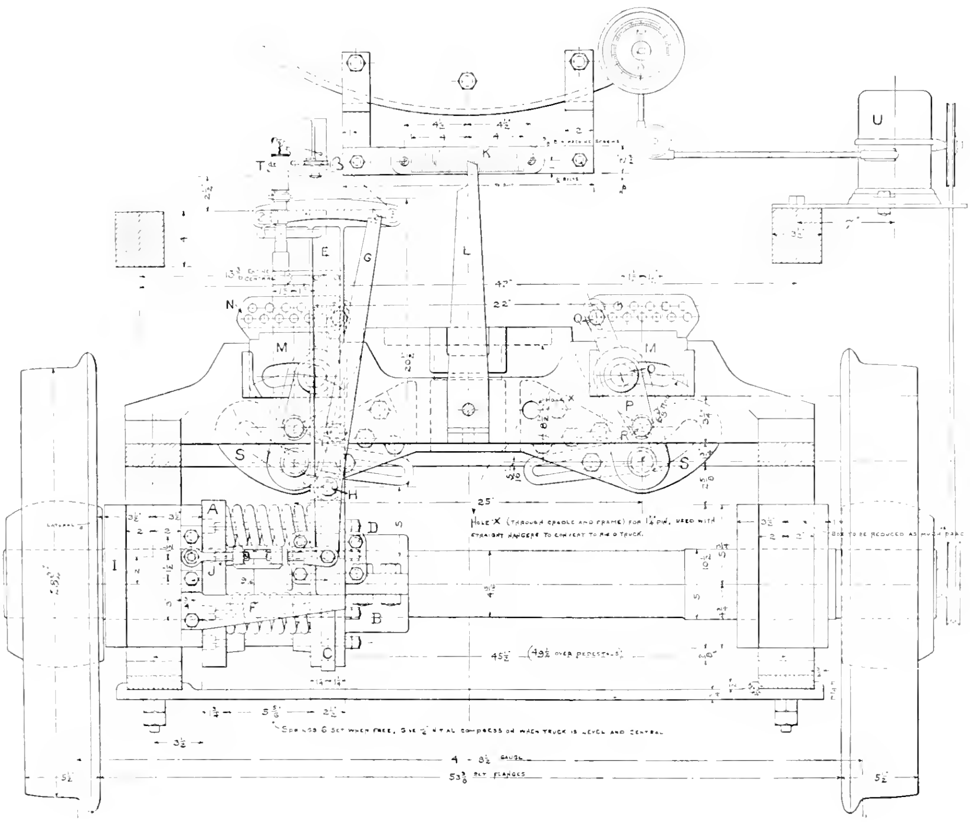
W. F. Bradley, W. H. Harrison, G. R. Joughins, A. E. Manchester, H. P. Robinson, Committee.

A year ago your committee submitted a report on the apprentice boy, which will be found published on pages 282 to 290 of the Re-

port of the Proceedings of the Association for 1896, in which your committee dwelt especially on the necessity of educating apprentices outside of the shops. Your committee in that report submitted the substance of correspondence with representatives of the University of Chicago and of Purdue University of La Fayette, Ind. Your committee in that report did not attempt to submit any definite course of training for apprentices in the shops. In the course of the discussion which followed, the committee was continued, with especial instructions to recommend a course of shop training for apprentices in the various locomotive shops.

In confining itself, therefore, to this one specific department of the training of the apprentice, namely, the training inside the shops, your committee does not wish to be understood as considering that this is the only department in which care and pains are needed in the educating of apprentices. It hesitates even to say that the shop training is the most important part of their training. Apprentices must be made not only good mechanics but good citizens and good men. It is easy to say that a railway company is not responsible either for the citizenship or morality of its apprentices, but it is none the less impossible for the company to escape some share of such responsibility—at least of the moral kind. Moreover, on purely selfish grounds, it is to the interest of the railway company to see that the generation which is growing up is not only a generation of competent workmen, but is also a generation of good citizens and good men. In confining itself to this report to the one subject of shop training, your committee is obeying instructions, and for the larger field of outside training it begs again to refer to its report of last year, and to say distinctly that the report submitted herewith is only supplementary thereto, and that the field of shop training is only one department of the much greater field of the general education of the apprentice.

The first question to be considered is the length of term of service which an apprentice should serve. On this subject there are two diametrically opposed views held respectively by those who would place a rigid term of service consisting of a certain number of years or months on the one hand, and on the other hand by those who believe that the length of a term should be governed entirely by the merit and ability of the individual apprentice. From reports received from a large majority of the bigger shops in this country, it is evident that the more general custom is the prescribing of a definite length of service. On the other hand, what the committee will call the merit system is in force in some shops whose practice we all recognize ought to command our highest respect; also the practice in other countries is in favor of the merit system as opposed to a rigid term of service, and in the discussion in the Western Railway Club at the May meeting already referred to the majority of opinion was distinctly in favor of the merit system. If a rigid term of service is fixed, the very great preponderance of practice in this country is in favor of a four year term. There are one or two cases when a three-years' term is considered sufficient. The committee knows of one case where the term is fixed at five years. The four-year term, however, is almost universal. The committee believes that this term has been fixed as the result of long experience, and is in accordance with good judgment. In four years a boy ought to be able to acquire a thorough training, if he is a boy capable of ever becoming a mechanic. At the same time, four years is not too long a time to make the average boy spend on his training.



Truck Swing Hangers.

In drawing up any shop course, therefore, it should be based on an assumption that it is to cover a period of four years. Your committee, however, does not believe that it is fair to make all boys spend precisely the same time on the same work. Any course must be more or less elastic. Boys differ largely in capacity and in ambition. Moreover, the same boy will show greater aptitude for one part of his course than he will for another. While, therefore, we believe that four years should be regarded as the proper average time of service, and a course should be based on that length of time, there must be left discretion in whoever has charge of the apprentices either to permit a boy to go forward more quickly, or to hold one who is slow longer than the average at a particular class of work. Your committee, however, would not by any means have this to be interpreted as meaning that the discretion of the individual in charge is to be unlimited. With the brightest and most ambitious boy the committee would under no circumstances recommend the shortening of the term below three years. The committee does not believe that any boy ought to spend more than five years. A boy who requires five years of service to go through his course

will certainly at an early stage of his training show such assurance of incapacity as to make it evident that he will never make a good mechanic. In such cases the boy should be promptly sent elsewhere. This power to discharge not only in case of misbehavior, but for the reason stated, namely, of a general incapacity in the boy, must be reserved by the railway company, and ought to be unsparingly and conscientiously used both in the interests of the shop and of the boy himself.

With this understanding the committee submits herewith a schedule for machinist apprentices, which is in use on the Norfolk & Westerd Railroad, and which has been found very satisfactory. [This schedule comprises the work on the machine tools similar to several which are employed on railroads of this country. The report presents schedules for boiler shop and blacksmith shop courses, and in an appendix an academic course and also a form of indenture are suggested. These are too long to be reproduced.—EDITOR.]

Locomotive Grates.

H. WADE HIBBARD, GEORGE W. WEST, DAVID BROWN and EDWARD L. COSTER, committee.

It appears in brief to your committee that a grate should be composed wholly of cast-iron shakers for fireboxes not over the drivers.

For wide fireboxes, those extending out over the drivers, using lump coal, transverse shakers alone, or longitudinal shakers lightened with water tubes between, are recommended.

For wide fireboxes over the drivers using small coal, shakers appear to be preferable in whole or in part.

The earlier locomotives in which attempts were made to use anthracite were rather deficient in grate area. The burning of this refractory fuel was not well understood and these small grates compelled the use of a high grade of coal in order to produce sufficient steam. This is stated by the Reading to have caused the burning out of the cast-iron grate bars then used because of the lack of ashes to settle upon them and protect them. The use of anthracite was consequently not really successful until water grate bars were designed. These were put in by James Milholland from the Philadelphia & Reading Railway. It is further stated by this road that no further trouble was had with melting of grates; and with proper design to give pitch enough to secure circulation, and reasonable care as to removable of washout plugs at ends of tubes and washing out the tubes when boilers are cleaned, it is stated that tubes are entirely satisfactory.

Closing up of tubes by accumulation of mud, with the resulting overheating and burning, appears to be common, even where the greatest precautions are taken in washing out.

Tubes rising up out of the fire is a prominent difficulty and is acknowledged by all but one of those even who prefer the tubes to the shakers. The Pennsylvania never has bars rise up unless they have been closed or nearly so with mud and scale.

Standard slope varies on different roads, but in general is about one inch in 12 inches. The Lehigh Valley uses ¾ inch in 12 inches. The Ontario prefers the greater rather than the lesser slopes; but regards the length and width of fireboxes as having a great deal to do with slope, and the depth from fire flues to water tubes more. Sufficient slope is, of course, needed for circulation in preventing the water from being driven out of the tubes.

Corrosion of tubes.—The Pennsylvania states that it has been quite a common occurrence to have tubes leak at the front and back sheets, and sometimes it is quite difficult to keep a tight joint. When a leak is once sprung it is often found difficult to get the joint tight. It is often found that corrosion has taken place around the joint, and to overcome the leak is still further made difficult.

Corrosion of side sheets is caused by an undisturbed lodgment of ashes against the sheet, and is particularly facilitated if there is also a leak.

Pull out bars are not recommended to enter from water leg. They are usually in the proprotion of one bar to two tubes, though the Delaware & Hudson uses about one to three. This is obtained by placing only two tubes together, but where a bar is placed as above next the sheet the proportion becomes one to three.

Supports for water tubes and bars are formed by cross-braces whose ends are attached to the mud ring. The Erie states that there should be one intermediate support for fireboxes 6 to 7 feet in length; two supports for fireboxes from 7 to 11½ feet long, which may be spaced unequally if necessary to clear drivers. In the longer fireboxes, if the front end of pull-out bar does not entee front water leg, it should be supported there also. At the rear thr thimble in water leg, through which the pull-out bar passes, should be reinforced inside to allow wear of bar; or else there should be a cross support there attached to mud ring. Long fireboxes must have the mud ring braced across from side to side to prevent spreading, and this furnishes an easy means for intermediate support of tubes and bars. To this cross-brace a cast-iron piece in one to three sections is bolted, its notched upper edges holding the tubes and bars. Wide fireboxes over drivers require a support made light by combining a 2½ by 3-inch square horizontal bar with a 1¼-inch truss rod having nuts at both ends.

The Erie's experience with tubes with filling pieces has not been satisfactory, and engines having this form of grates have been fitted with shaking grates. It was used in engines having either the true Wooten or plain fireboxes over the drivers. There were four drop grates, two in front and two behind, in line with the fire doors. Cleaning the fires was difficult and slow, in which the Lehigh Valley and Ontario concur, and the volumes of cold air which entered the firebox when the drop grates were opened proved very injurious to the flues.

Water tubes with transverse shaker fingers and pull-out bars between are entirely successful on the Delaware, Lackawanna & Western, which uses the combination on passenger engines only. A description is given that "these shaking grates occupy half of the front end of the firebox and have cast fingers which work between water tubes. There are pull-out bars for the remaining portions of grate which occupy the space in the back between the tubes that the shakers do in the front part of the firebox. At first shakers were tried between water tubes the whole length of the firebox; but it was found that it was not necessary, since shakers as now used in front are sufficient. They give good results in passenger service on long runs, where it is necessary to stir up the fire in front end of firebox." There is little or no trouble with the fingers warping and burning.

Technical literature appears to be singularly lacking in the history of the details of the use of anthracite in locomotives, but your committee learns that it is only within the past decade or less that the railroads of this country have been making any efforts to use shaking grates. Their most extensive use to-day is to be found on the Erie Railway, their adoption dating from the early part of 1890. Before this time, water tubes with pull-out bars had been used and were a source of continual trouble. The Erie has now very few locomotives thus equipped. Upon these will be applied, whenever renewals are necessary, either the standard 40-inch cast-iron shaking grate, or a somewhat shorter 32-inch standard grate of same width and general design, with ½-inch fingers and ⅜-inch openings for pea coal, and thicker cross ribs of 4½ inches maximum depth, used for fireboxes over the drivers. The Erie has found no defects in shaking grates.

The advantages of the shaking grate, in addition to an avoidance of the disadvantages of water tubes, are stated by different roads as follows:

Cleaner and thinner fire and softer exhaust; the improvement of the fire during very long runs by stirring from beneath; quickness and small labor in cleaning fires at stops and terminals (Section 28); ability to use cheap coal having a great amount of refuse (Section 29); economical use of coal; less harmful effect on firebox sheets; less first cost; simplicity, as regarded by the Erie; greater safety, since there are no tubes to burst, no sheets to be injured by rolling and caulking, and no unexpected breakdowns; durability with less careful handling; less expense to keep in good condition; advantage in poor water districts, since water has no effect; quickness and cheapness of repair.

The weight of longitudinal shakers, if without intervening tubes, is four or five times as much as the weight of water tubes and pull-out bars. This has led to the introduction of one or two tubes between shakers, solely on grounds of lightness.

That a cleaner and thinner fire, as well as a softer exhaust, can be used with shaking grates is the experience of the Pennsylvania. The great number of small openings instead of longitudinal openings running the entire length of the firebox prevents much of the small coal shaking through. The Ontario also considers that a thinner fire can be carried on shaking grates; while the Lehigh Valley and the Erie in general see no difference, though some of the latter's Master Mechanics have found the Pennsylvania and Ontario experience to be their own. The softer exhaust required would naturally decrease the cylinder back pressure, and thus increase the power of the engine.

Cheap coal can be better used upon shaking grates because the great amount of ash and refuse is easily removed while running. One branch division uses coal of even 27 per cent. ash upon passenger engines with fireboxes between frames and with shakers. Such coal in so small fireboxes does not give free steaming, but it is referred to as showing what can be done with shakers. Anthracite railroads are finding it necessary sometimes to use slaty coal which they have mined but cannot sell, or which must be purchased from heavy coal shippers; also, in common with all roads, they have some inexpert firemen, who need every advantage to make steam even with good coal.

Economical use of coal is reported by the Erie, Lehigh Valley and Pennsylvania, due to less loss by dropping through the grate and less loss when cleaning fire. The opinion of the New York, Ontario & Western Railway had been that there was a considerable saving by the use of shaking grates over water bars under like conditions of coal, service and engine crew; but the series of tests which have been carried on by the committee, made possible by the kindness of the above road, have not demonstrated this saving. There is more difference in crews than in grates.

First cost is stated by the New York, Ontario & Western to be in favor of the shaking grates, the material alone costing about four-sevenths more for water tube grates than for shaking grates.

The durability of shakers is greatly in evidence, though less care is needed to secure it. With proper locks the fireman is automatically careful and very much less care is needed in the roundhouse in the shape of weekly inspections and washing out of tubes.

Shaking by sections is recommended by the Schenectady Locomotive Works: "A surface 40 inches wide by 11 feet long being divided into three parts, giving greater ease in handling and permitting the different portions of the fire to be cleaned separately." The Pennsylvania pursues this plan upon its latest engines. The Erie and Ontario state that a section of 20 square feet is the maximum that one man can handle to advantage, 12 to 15 square feet being much more advisable.

The advantages of the longitudinal grate over the transverse are as follows: No side-bearers to give weight and corrosion; no intricate or short lived side-bearer supports; fewer and more simple parts, including lever connection; can be lightened by tubes in narrow fireboxes; standard castings rather more profitably adapted for all widths of fireboxes by using one or two intervening tubes than by the filling pieces used for the same purpose with transverse shakers; easier to locate cross-support to avoid driver.

The disadvantages are: Cannot shake front and back parts of fire separately; more difficult to renew; long sections warp sidewise worse; longer sections must be stronger and heavier, especially in the bellying rib; requires more locks; standard castings not so easily adapted to all lengths of fireboxes.

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

SEPTEMBER, 1897.

CONTENTS.

Coal Bunker at Tacoma—Northern Pacific Railway.

The new coal bunkers built by the Northern Pacific Railway at Tacoma, Washington, for the purpose of loading vessels at that port, combine large storage capacity with economy in handling coal and low construction cost for the plant. We acknowledge the courtesy of Mr. E. H. McHenry, Chief Engineer, and Mr. Charles S. Bihler, Division Engineer of the Northern Pacific Railway, for the drawings, photographs and information which form the basis of this description.

Coal bunkers used for the storage of coal to be loaded into vessels have usually been built out into the water, and as it is necessary to provide for vessels of deep draft, the substructure has necessarily been very costly, especially in salt water where timber work is exposed to the attacks of the teredo. An additional difficulty arises on account of tides, the extreme range at the Puget Sound ports being about 20 feet. In order to allow vessels to load at nearly all stages of the tide, a large amount of storage coal must be elevated to a considerable height, and, as a consequence, the cost of coal bunkers constructed on the ordinary plan is considerable per ton of storage capacity.

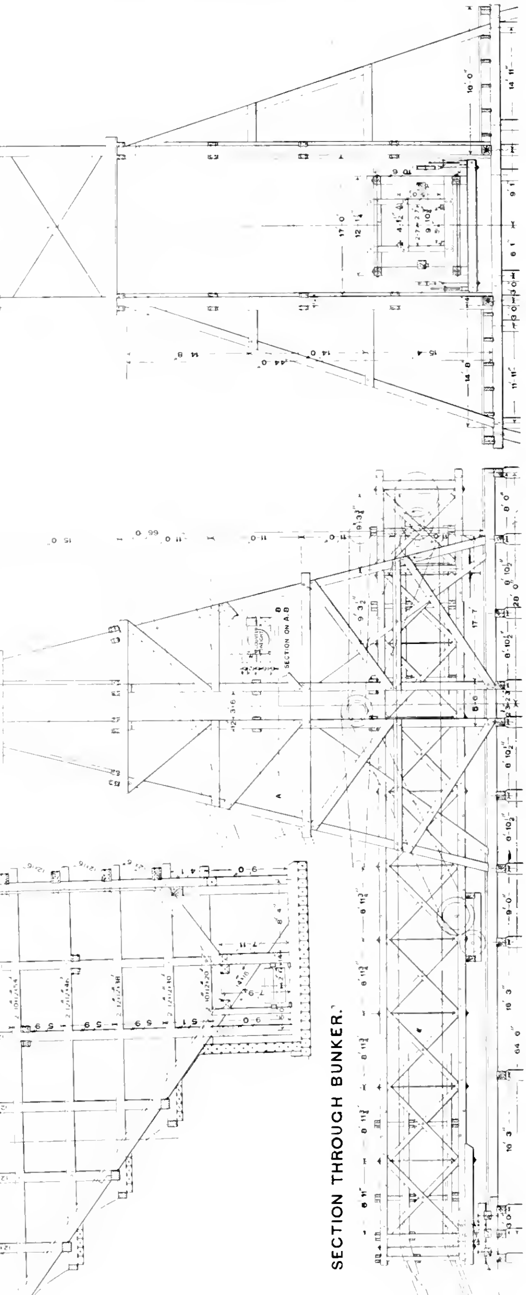
With the new plant advantage has been taken of the peculiar formation of the shore. From the water's edge the ground rises very abruptly to a height of several hundred feet, the formation being hardpan and cement gravel. On this bluff the foundation for the bunker has been prepared by excavating a slope of the proper angle to make the coal run freely.

The bunker itself consists of a box, with a sloping bottom, which has been set on this slope. The coal is dumped into the bunker from the top, two tracks running its entire length and being connected in such a manner as to make operation as convenient as possible. The engine pushes the loaded coal cars up on the tracks constructed behind the bunkers. They are then allowed to run back over the bunkers by gravity, are unloaded and collected when empty on one of the tracks below the bunkers, whence they are returned to the yards. The coal is taken out at the lower end of the bunkers through gates into conveyors, which run the entire length of the bunkers. There are two conveyors leading to the middle of the bunker, where coal is discharged into the sea conveyor, which runs at right angles under the yard tracks out to deep water. At the outer end of the sea conveyor provision is made for the tides and for the different loading stages of the vessels by a bridge 100 feet long, which is pivoted on one end and can be raised and lowered at the front end. The conveyors consist of a series of pans, four feet wide, two feet long and one foot deep, supported by wheels and running on light rails. They are driven by two electric motors, one 50 horse-power, at the head of the sea conveyor, and one of 20 horse-power, which can be thrown into gear with either of the lateral conveyors. The bridge itself is counterweighted and the raising and lowering is done by power furnished by the motor running the sea conveyor. To run the coal from the front end of the sea conveyor to the hatch of the vessel an extension chute is provided, which can be extended or shortened, raised or lowered by power. Only two men are required to operate

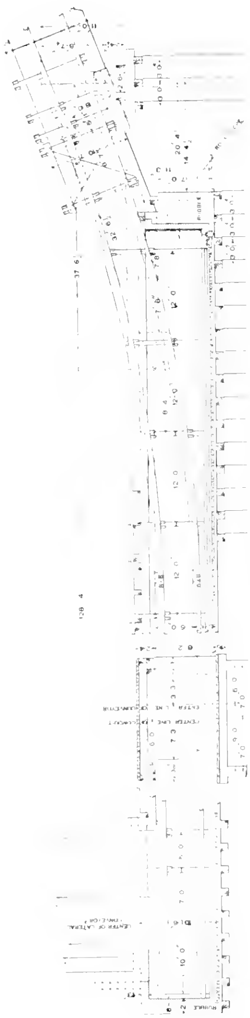
General View of Bunker and Chute Tower.

the entire bunker. One is stationed at the particular gate of the bunker from which the coal is being taken. He regulates the flow of the coal into the conveyors. The other man is stationed at the front end of the bridge, where he has control of the motors and where a number of levers are arranged by which all the different movements are governed.

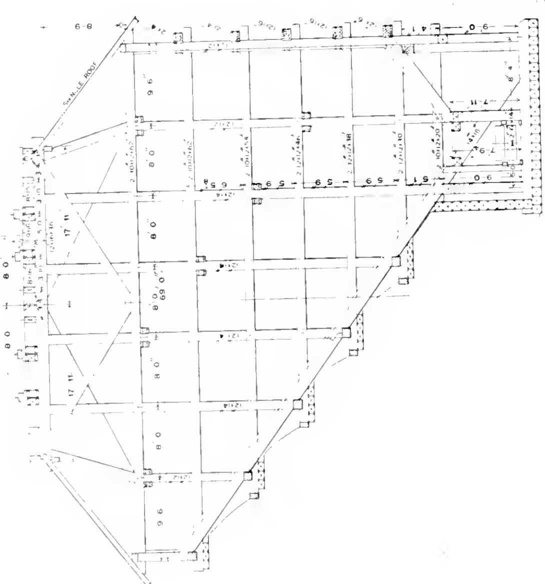
The machinery for the bunker was furnished by the Link-Belt Machinery Company, of Chicago. The specified capacity of



SIDE AND END VIEW OF RIDGE AND TOWER.



SECTIONAL VIEW OF SEA CONVEYOR CONDUIT.



SECTION THROUGH BUNKER.

the conveyors is 400 tons per hour, but it is found that the conveyor is capable of handling between 500 and 600 tons of coal per hour. The capacity of the bunker itself is 17,000 tons, enough for three or four good-sized cargoes. The average time consumed in loading a vessel is about 15 hours, depending somewhat on the dispatch it is possible to give to the trimming of the vessel. Since the bunkers first started no delay has occurred to any vessel on account of the stage of the tide. They have been able to take cargo on their arrival and finish it without interruption.

The adaptation of electric motors to these operations is of particular interest, and from an examination of the plans we reproduce it will be seen that by their employment a very simple arrangement of the machinery is made possible.

Compressed Air Traction.

The Hardie compressed air locomotive, designed and built by the American Air Power Company, 160 Broadway, New York, was illustrated and described in our issue of March, of the current volume, and in the May issue following we reprinted a statement of the cost of operating air cars on the 125th street line of the Third Avenue Railroad in New York. The interest which has been awakened by this experiment and by the one in prospect on the New York elevated roads makes it appear advisable to give the following resume of the present state of this equipment, which is taken from a recent publication by the company referred to :

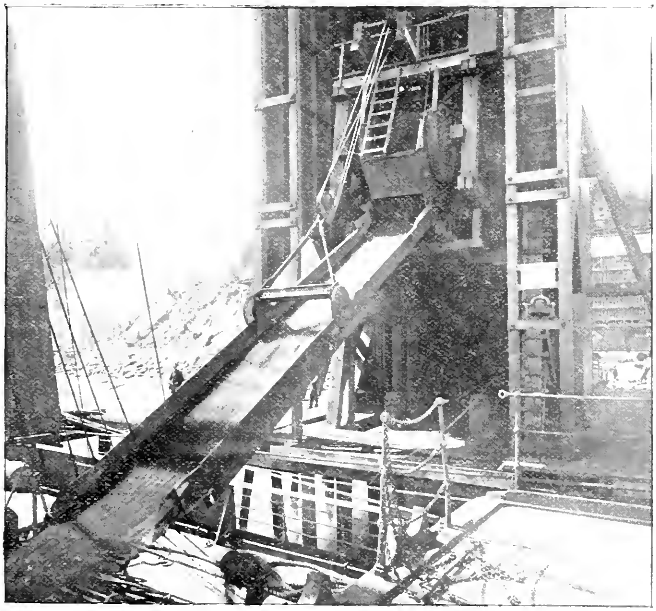
Two street cars of the "Hardie" type were put in operation on 125th street on August 3d, 1896. They have operated since that date without accident or failure, and have carried 188,854 passengers and traveled 32,189 miles. Each car is provided with 51 cubic feet of air storage, and runs from 13 to 17 miles at average speeds and making usual stops, and can be recharged with air in less than two minutes. Mr. A. J. Elias, President of the Third Avenue Railroad Company, says as follows :

"Your cars, operated by compressed air, have been steadily operated on the 125th street line of Third Avenue Railroad Company since the 3d of August last.

"They have been easily handled, started, stopped and reversed, the last named quality being a very desirable feature, reducing the liability of accidents.

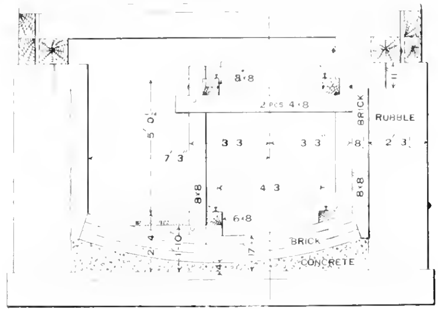
"Of course the advantage of a motor that operates independently of connection with any subterranean motive power is apparent.

"The motors are capable of attaining high speed and overcoming considerable gradients."



Front View of Chute in Service.

Signed statements of more than 200 residents of 125th street bear evidence to the fact that the service has been most satisfactory.



Section of Conduit.

Endorsements from these people who ride upon the cars daily, who see them continually in operation, and who depend upon them for service, and many of whom would like to see them replace all of the other cars upon that street, bear evidence to the popularity of these cars with the public.

The cars operated on 125th street are 28 feet long, and weigh 18,000 pounds each. The load being spring supported, they are easier and cause less wear of track than cars of the same design, size and weight by other systems. They can be run upon any railroad track and require no special construction and they can be gradually introduced into service, as existing equipment wears out, so as to require no large initial expenditure.

The machinery on the car and in the power station is of a simple character, slow in its movement, causing little wear and is maintained at a small cost.

The amount of free air used by these cars per mile operated to date is 460 feet, while for the last three months it has only averaged 409 feet. This air is stored in the motor at a pressure at starting of 2,000 pounds per square inch, and is reduced to working pressure by a specially constructed valve. A properly constructed power plant to operate 100 cars will compress this air at a cost of three cents per thousand cubic feet, including maintenance, labor, fuel and interest on the cost of the compressing station.

The pressure at which the air is to be stored in the cars being always known, it is merely necessary to provide sufficient strength of metal to hold it. The most careful inquiry fails to reveal a single instance in this country, since air has been used in operating machinery or motors, where anyone has ever been killed or seriously injured by it. The tubes used are in every instance tested within the elastic limits of the metal to double the pressure used in practice, and it takes about three times the actual pressure used to burst them, as shown by actual tests.

Locomotive No. 400, already referred to, was completed at Rome, N. Y., some months ago, and has been operated upon the tracks in that city.

It is now in New York waiting for an opportunity to run on the Manhattan Elevated Railroad. It has operated with same load and conditions as nearly as could be arrived at, at Rome, performing the service that will be required of it on the elevated structure, with a margin of air remaining. This was determined by measuring off a piece of track equal to the distance between the stations on the Manhattan Elevated and making the runs between these stations with the relative load, and stops, similar to the practice of

the Manhattan Elevated. Freight cars of a corresponding draw-bar pull of a Manhattan train were attached during these runs, and the motor performed the service in a noiseless manner and with ease Frequently in getting out from the tracks of the locomotive works' yard heavy trains of freight cars on the siding were shoved back, and on one occasion 10 heavily loaded freight cars, aggregating a load of over 300 tons, were easily moved for some distance.

There are no principles employed in the operation of this locomotive which differ from those used in operating the air cars on 125th street, previously referred to. If given loads, speeds, grades, etc., are stated, the air consumption can be accurately determined, and there is no economic or mechanical reason why compressed air motors should not be employed in all city and suburban work.

Attention of steam railway people is called to a special design of car furnished us by a prominent Western railway, to which we have applied the Hardie motor. This car is 72 feet long, seats 130 people, with standing room for 50 additional passengers. This car carries sufficient air storage to run 28 miles with a single charge of air, and the motor, located on one of its trucks, has sufficient power to accelerate to a speed of 45 miles per hour, stopping at stations located 3,000 feet apart.

A modified form of car built on this plan will fit almost any kind of suburban service, and the motors, being noiseless and free from nuisance, may leave the main line on reaching the city and will be permitted in its streets on the same tracks with horse, cable, or electric cars.

Attention is also called to the design of double deck car now being supplied by this company for service in England, and designs are now being completed for snow plows for general street service in the city of New York.

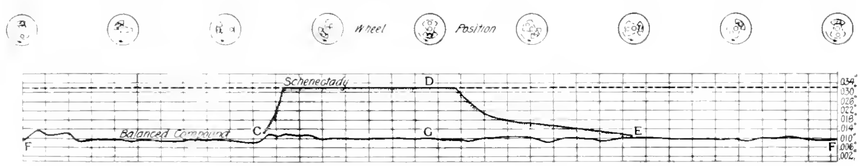
Tests of the Strong Balanced Locomotive.

Most of our readers are probably aware that a locomotive designed by Mr. Geo. S. Strong, and built by the Balanced Locomotive and Engineering Company, of New York, has been undergoing tests at the Laboratory of Purdue University under the direction of Mr. Geo. S. Morison, Vice-President of the Company, and Professor W. F. M. Goss, Director of the Laboratory.

This locomotive has four cylinders. It is of the compound type, and the high-pressure cylinders are placed between the frames while the low-pressure cylinders are outside of the frames. The low-pressure cylinders are connected to the driving wheels in the ordinary manner, and the high-pressure cylinders are connected to cranks in the forward driving axle. The high-pressure cranks are placed at 180 degrees from their corresponding low-pressure cranks, and the cranks of one pair of cylinders are at right angles to those of the other pair. The design possesses the interesting feature of high and low-pressure reciprocating parts of exactly the same weight, from which it is clear that the balancing of the reciprocating weights is perfect. The revolving weights are balanced in the wheels and in extensions to the cranks of the cranked axle. We expect to illustrate some of the special features of the design, including the valve motion, in a future issue.

Two series of tests have been made, one for the efficiency of the engine and one for the effect of the counterbalancing on the running of the engine. The report on the latter series has been made public and is entirely satisfactory in showing that the design of the engine is correct in this regard. The counterbalance tests were carried out after the manner adopted by Professor Goss and described in a paper by him read before the American Society of Mechanical Engineers, in December, 1894. This method makes use of small copper wires, which are passed between the driving wheels of the engine and the supporting wheels of the testing plant, while the engine is running. The indentations made in the copper wires by the wheels are measured to show the effect of the counterbalance weights on the pressure of the wheels against the rails.

The tests showed a maximum total variation in the thickness of the wire of 0.006 inch, and a comparison of the effects of the counterbalance of this locomotive and that known as Schenectady No. 1, upon which Professor Goss' earlier tests were made, is shown in the accompanying diagram. By an examination of this it will be seen that the counterbalance weights of Schenectady No. 1 raised the wheels entirely clear of the rails during a portion of the revolution. The line *C D E* of the diagram represents the wire from the locomotive as ordinarily counterbalanced, and the line *F G F* shows the effect of the balanced compound. In this comparison it should be noted that Schenectady No. 1 had driving wheels 62.5 inches in diameter and ran at a speed of 337 revolutions per minute, the excess balance being 400 pounds. The balanced compound has driving wheels 67.4 inches in diameter and ran at a speed of 323 revolutions per minute, there being no excess balance in this case. The nearly uniform thickness of the wire from the balanced compound shows that the weight or pressure of its driving wheels upon the rails is practically constant throughout the revolution of the wheels. From an examination of the diagram it will appear that the wire from Schenectady No. 1 increased in thickness as the counterbalance approached the upper quarter. In the tests it was observed that with the balanced locomotive there was almost a total absence of jerking forward and backward and of nosing. Both of these motions are quite noticeable in locomotives balanced after the usual manner, when they are running at speed upon the rollers



Comparative Effect of Counterbalance.

It is stated that there was almost no side swing of the front of the engine at speeds ranging from 30 up to 60 miles per hour, the latter speed being the maximum attained during these tests. Professor Goss' report upon the counterbalancing feature of the engine concludes as follows:

"Whatever the speed, the wheel pressure of the balanced locomotive will not vary except as the wheels may be acted upon by accidental forces, as, for example, impact due to inequalities in the track or changes in the position of the center of gravity of the heavier portions of the machine relative to wheels, through the engine rocking or tipping on its springs. The wheels at all speeds turn smoothly, while the machine as a whole remains almost motionless. Oscillations of every sort which appear in the balanced locomotive are of less than one-half the amplitude of those which attend the action of a locomotive of the ordinary type. It is evident, therefore, that the means adopted to secure perfectly balanced wheels have also served to greatly increase the steadiness of the locomotive as a whole."

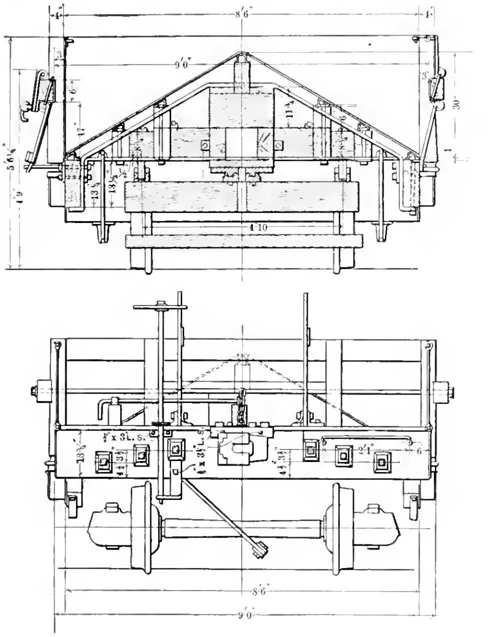
We expect to describe the efficiency tests in a future issue.

Cinder Car—Great Northern Railway.

By courtesy of Mr. J. O. Pattee, Superintendent of Motive Power of the Great Northern Railway, we illustrate a new design of cinder car which was devised with special reference to economy in loading and unloading cinders. The construction is such as to bring the sides of the car as low as possible for the purpose of cheapening the cost of loading by hand shovels.

The tops of the side sills are flush with the bottom faces of the center and inside intermediate sills, the outer intermediate sills being one-half inch lower than the inner ones. The top faces of the end sills are flush with the center sills, and the end sills are 13¾ inches deep. A cast-iron shield is placed on top of each sill. These are made in sections about 4½ feet long, and are used to prevent hot cinders which may be thrown into the car from injuring the sills. The car is lined throughout with No. 12 iron, and the ends are made of iron plates, as also are the doors. The 4 by 6-inch plates and the posts are sheathed with iron with a view of rendering hot cinders harmless to these members. There are four doors on each side of the car which are opened and closed by levers at the end of the car, each lever controlling two doors. The levers are held in place by an end door latch and buttons when the doors are closed. The doors are not only closed, but are pushed open by means of the levers, which is found to be advantageous when the doors are stuck by freezing. This mechanism after considerable experience is found to operate sa isf ctor.ly

The novelty in the construction is that the car is low, and the side sills are dropped so as to gain every possible inch in the height through which the load must be shoveled. The total



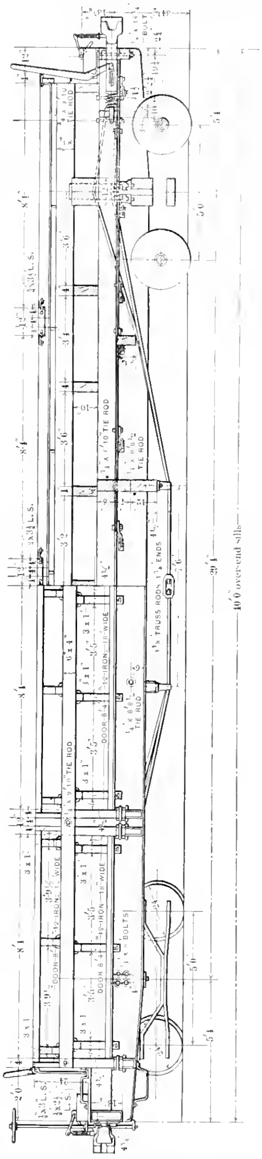
Cinder Car.—End View and Section.

height from the rail to the tops of the car sides is only 5 feet 6¼ inches, and advantage is taken of the top doors to reduce the height to 4 feet 9 inches during the first part of the loading. These doors are hinged downward. It will be noticed that the wheels are small, being 24 inches in diameter, for the same reason, and the whole car appears to be about as low as it is possible to make it. The pitch of the inclined floor appears to be rather steep, but the slope was fixed after experimenting. The height of the ridge was first made 6 inches lower, but it was raised to facilitate unloading. Trial also showed the necessity of using six truss-rods, the location of which may be seen in the end view. The car is fitted with the American continuous draft rigging and with air-brakes, though the attachment of the brakes is not shown in our engravings. The design is by Mr. J. O. Pattee, Superintendent of Motive Power, and Mr. E. A. Wescott, Superintendent of Car Shops.

Modern Marine Boiler Furnaces.

The influence of the corrugated furnace upon the development of the marine engine to its present state has directed considerable attention to the furnaces and we reprint the following paragraphs from an article on the subject by D. B. Morison in *Cassier's Magazine*:

Corrugated furnaces are made from Siemens-Martin steel ingots, which are rolled into plates under ordinary plain rolls. Three sides of the plate are sheared, and on the fourth side the development of the saddle is marked and punched out. The plate is then taken to the bending rolls, where it is formed into a tube, after which it is heated by water gas, and lap-welded by hammers of special design.



Cinder Car.—Half Side Elevation and Half Section.

This welded tube is next heated in a special furnace and placed in the corrugating mill, in which complete corrugations are formed by one revolution; but a few turns are given for finishing, and after being allowed to remain until it is sufficiently cool, it is withdrawn as a perfectly cylindrical, corrugated tube. It is then taken to the flanging shop, where the back end is flanged by a hydraulic press, the final process being annealing. Furnaces for the British and other Admiralties are subjected to a pickling process in a solution of hydrochloric acid, which effectually removes all scale, and thus enables the most searching examination to be made.

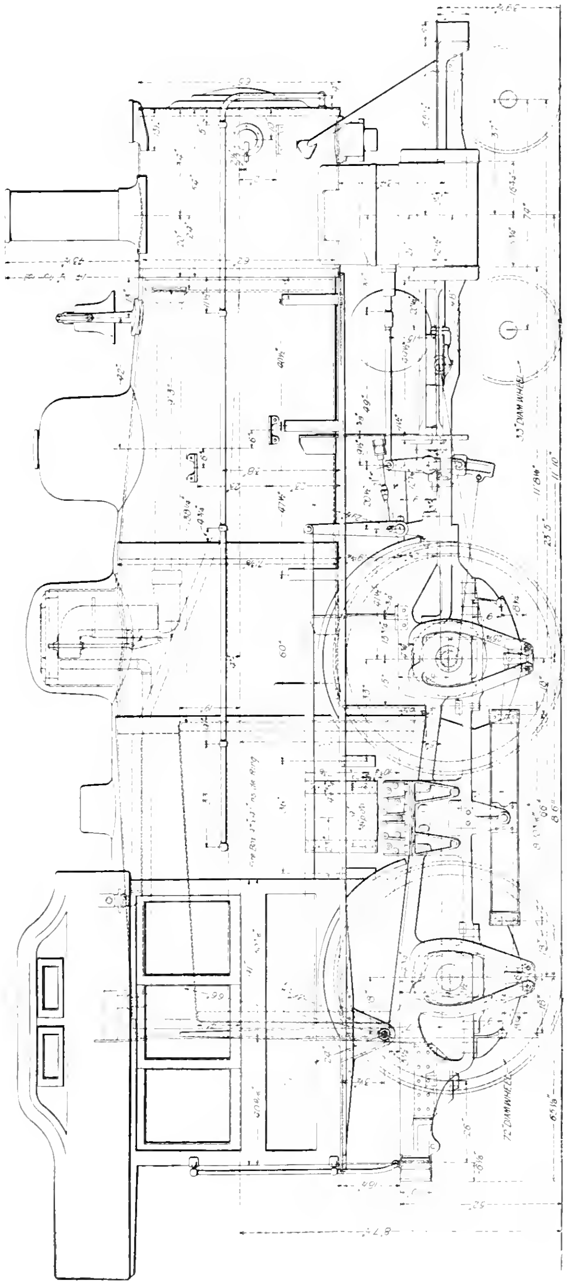
The furnace which was the greatest rival to that of Fox is that known as the Purves ribbed flue, made by Messrs. John Brown & Company, Limited, of Sheffield, England. This furnace consists of a series of thickened ribs, 9 inches between centers, the part between these thickened ribs being of plain cylindrical section.

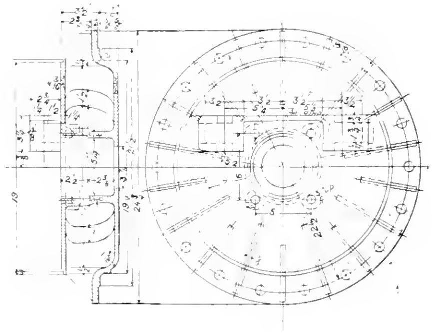
The Purves flue is made from a Siemens-Martin steel ingot. Rectangular section slabs, sufficient for two flues, are formed from these ingots under a hammer, the slabs being 7¼ inches thick, and their length being equal approximately to the length of the flue required. Special roughing rolls convert the slab into a ribbed plate 1¼ inches thick, which is then cut in two by powerful shears, and, after reheating, each half is passed through finishing rolls until the final required thickness is obtained.

After being sheared at the edges, the plate is bent into a circular form by a hydraulic press, and the edges are then welded together by the insertion of glut pieces, the plain parts being welded first and the ribs afterward. The furnace is then heated and converted into a circular tube by a very ingenious hydraulic press and afterward flanged in the ordinary way, the final process being annealing.

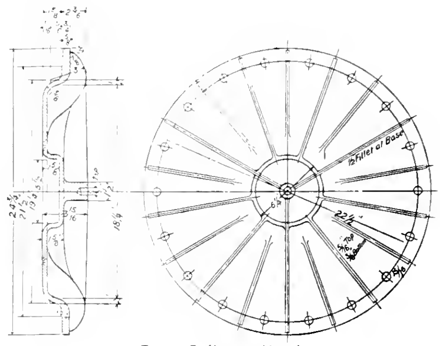
A later design, the Morison suspension furnace, is an improvement on the Fox corrugated t pe. It is manufactured by the Leeds Forge Company, Limited, in exactly the same manner, the same processes being employed throughout.

The suspension furnace consists of a series of long curves projecting inward toward the fire, each curve being approximately a catenary, or the form which a chain assumes when supported between two points. This long suspension curve is the feature of the furnace which has proved so successful in practice, as the tension is more uniformly distributed than in the Fox section, with its series of semicircles. There are no inward narrow cavities, and, cons quently, there is less liability to local overheating, while the long inward curves present a more efficient heat-absorbing surface and there is considerably less tendency to alter in form under severe conditions of work.

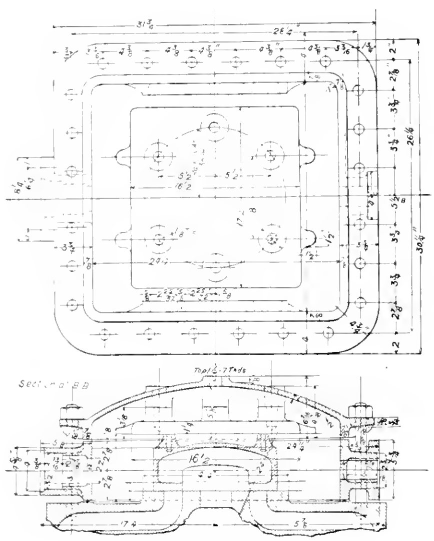




Back Cylinder Head.



Front Cylinder Head.

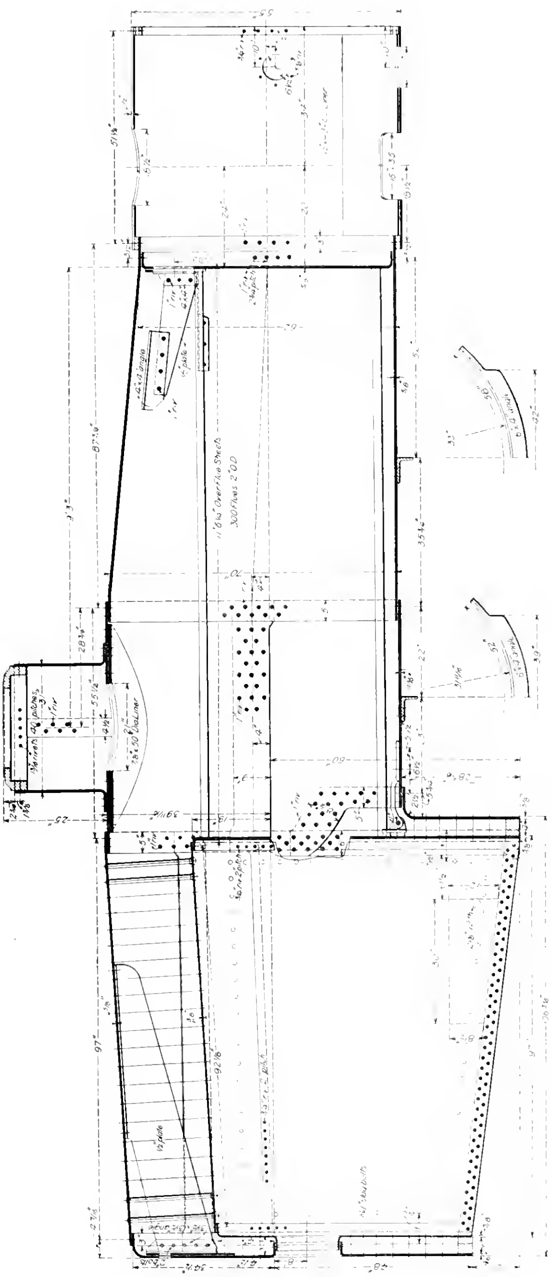


Steam Chest and Cover.

EIGHT-WHEEL LOCOMOTIVE. CHICAGO, INDIANAPOLIS & LOUISVILLE RAILWAY.

H. WATKEYS, *Master Mechanic.*

BROOKS LOCOMOTIVE WORKS, *Builders.*



LONGITUDINAL SECTION THROUGH BOILER.

Details of Eight-Wheel Brooks Locomotive, Chicago, Indianapolis & Louisville Railway.

The general dimensions and specifications of the new eight-wheel locomotives recently built by the Brooks Locomotive Works for the Chicago, Indianapolis & Louisville Railway, the Monon route, were given with an engraving from a photograph in our August issue, and through the courtesy of the builders we now present some of the details of the design.

The side elevation shows the general appearance of the engine, the boiler outline, the running gear and equalizing arrangement. It will be seen that the frames are forged down and that the firebox is above them. The firebox is $50\frac{1}{2}$ inches wide outside and the frames are spaced 46 inches between centers. The weight of the back end of the boiler is carried upon a bracket resting upon a casting which imparts the load to both bars of the frame and bosses in the lower part of this casting support the driver brake hangers. The equalizer fulcrum is in the form of a yoke lipped against the inner face of the frame and carrying bosses at its lower end for the equalizer pin. The equalizer is an I beam 9 inches high and 69 inches long. Its center support is a casting fitted between the flanges on each side and held in place by four bolts. At the ends castings recessed for the ends of springs are fitted, and the web of the I beam is cut away to admit the springs. The springs are underhung and are seated on saddle castings from which curved links carry the load to the tops of the driving boxes. The outside ends of the springs bear against steel castings bolted to the frames.

The entire working deck of the engine and tender are on the same level. This was done for the convenience of the engine runner and fireman and it gives them the use of the whole floor of the cab which is flush from the front end of the cab to the back end of the coal space in the tender. From the photographic view shown last month the tender deck is seen to be level with the running board of the engine. The rear ends of the frames terminate in slabs to which the frame foot plate, of cast steel, is bolted. A 10-inch channel is placed across the ends of the frames and a strong ribbed cast-iron bracket from the foot plate bears against its front face while the rear face carries the chafing plate.

The small number of courses in the boiler has already been remarked and the longitudinal section shows their arrangement. The taper course is $\frac{5}{8}$ inch thick. The dome course is $\frac{11}{16}$ inch, the outside firebox sheet is $\frac{5}{8}$ inch, the crownsheet is $\frac{3}{8}$ inch, the side sheets are $\frac{5}{16}$ inch, the back firebox sheet is $\frac{3}{8}$ inch; the back head $\frac{9}{16}$ and the tube sheets are $\frac{5}{8}$ inch; the throat sheet is also $\frac{5}{8}$ inch. The back end of the boiler tapers downward and inward bringing the crown stays of of equal length in each row. The tubes are 2 inches in diameter, placed at $2\frac{3}{4}$ inches pitch and the spacing opposite the widest part of the firebox is radial instead of in vertical rows. As seen in the sectional view of the engine the feed pipes from the injectors are carried forward to about the usual location of the check valves. A liberal supply of washout plugs is provided, over the crownsheet, in the water-legs, and there are four in the front tube sheet, two near the bottom of the shell and one in the center of each side of the group of tubes. Two tubes are omitted in order to get in the last-mentioned plugs. The back heads are stayed with $\frac{1}{2}$-inch gusset plates, secured to the head between pairs of angles, while the attachment to the shell is by means of a flange turned over on the gusset, as shown in the combined end view and section of the

boiler. All of the rivet holes in the boiler are reamed in place.

Cast steel has been extensively used in this design and the weight thus saved is about 5,000 pounds. The cast-steel parts include the boiler expansion and supporting brackets, equalizer fulcrum and end castings, spring seats, driving boxes, footplates, driving wheel centers, steam chests and covers, pistons, crossheads, cylinder head and truck center casting. Several of these details are shown in the drawings and beyond a statement of the weight of the castings no description of them seems necessary. The weights in the rough are as follows:

Two pistons, 326 pounds; two front cylinder heads, 270 pounds; two back cylinder heads, 476 pounds; engine truck, center casting, 529 pounds; two steam chests, 532 pounds; two steam chest covers, 485 pounds, and two crossheads, 300 pounds. The crossheads are of the four-bar type and at 150 pounds each they are very light. The finished weights were not taken, but they are probably between four and five per cent. below the weights in the rough.

Master Mechanics' Association Subjects for 1898.

The proceedings of the American Railway Master Mechanics' Association for 1897 which have just been received from the Secretary, Mr. John W. Cloud, announce the following list of subjects for the convention of 1898:

Tonnage Rating for Locomotives; Advantages of Improved Tools for Railroad Shops; Best Form of Fastenings for Locomotive Cylinders; Best Method of Boiler and Cylinder Insulation; Efficiency of High Steam Pressure for Locomotives; Square Bolt Heads and Nuts and Standards for Pipe Fittings; Air-Brake and Signal Instructions, and the Apprentice Boy.

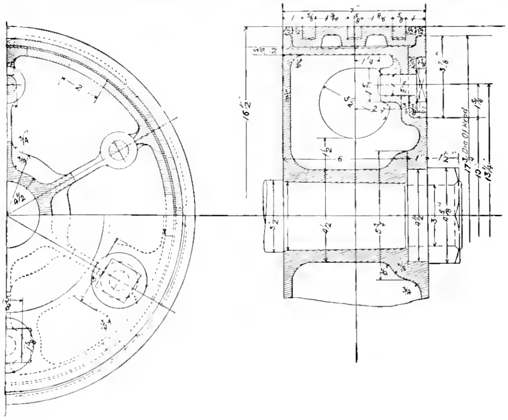
The subject Application of Electricity to Steam Railroads was made a part of the programme for next year and the following questions not reached at the last convention are carried over: The Special Apprentice; Arrangement of Front Ends of Locomotives to Clear Themselves of Sparks; Advisability of Systematic Course of Engineering in Connection with Technical Schools, and The Use of Steel in Locomotives.

The Pneumatic System on Shipboard.

Captain Purnell F. Harrington, U. S. N., commanding the monitor *Terror*, senior member of the board appointed to examine the pneumatic system for working the turrets and guns, steering and refrigerating upon that vessel, has submitted a report to the Department which is of a more favorable tenor than many naval officials expected would be made. Captain Harrington according to the *Army and Navy Journal*, states the advantages of the pneumatic system as follows:

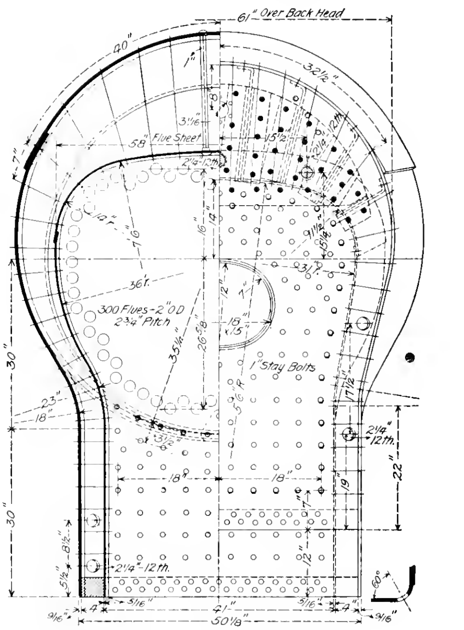
Whenever an air compressing engine is installed the power desired for any purpose may be obtained in excess of any steam pressure available. Air power motors may be substituted outside of the main engine-room everywhere below decks instead of steam engines, such as steering engines, anchor and hoisting engines. Those parts of the pipes would then have an agreeable temperature instead of being uncomfortably and hurtfully heated by the presence of steam pipes. Air leaks and broken air pipes impose no danger whatever, while steam leaks and broken steam pipes, particularly in action, are dangerous and alarming. Air leaks are quickly found and stopped, and they give no increase of temperature or flood of water or any personal inconvenience to those in the compartment. There is immunity from freezing pipes. Air motors require no special exhaust pipes, but the exhaust may be turned into the air or used for the ventilation of the compartment. Air motors may be started or stopped suddenly with little danger of injury to the motors. Compressed air is always ready for work, without freeing the pipes preparatory to starting motors.

The system is, in operation, as witnessed by the board, clean and free from danger and inconvenience, and free from difficulties in ascertaining or removing causes of trouble, which freedom is not inherent in any other system of turret and steering machinery. While the board is pleased with the pneumatic machinery on board the *Terror*, it recognizes the fact that it is an experimental design. The board is of the opinion that a new design would produce results even more satisfactory than those on board the *Terror*.



Cast Steel Piston.

The examination of the pneumatic system covered a period of five months, and the board describes as "excellent" the behavior of the turrets, guns and steering gear. It has been repeatedly demonstrated that when the ship is at a speed of from six to eight knots, and there is a pressure in the steering cylinders of 125 pounds per square inch, the helm can be moved by the air piston from hard over one side to hard over the other side (68 degrees) in seven seconds.



Section through Firebox.

The only criticism made by the board relates to the air compressing engines. These, it declares, are of obsolete type, and run at low speed, and a recommendation is made that they be replaced by compressors of recent design which run at high speed.

Up to the present there has not been even a horse street railway in Siberia, but an electric line is now building in Vladivostok.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

Chemistry applied to Railroads.—Second Series.—Chemical Methods.

XXI.—Method of Determining Proportions of Oil, Turpentine, Pigment and Moisture in Passenger Car Color.

BY C. B. DUDLEY, CHEMIST, AND F. N. PEASE, ASSISTANT CHEMIST, OF THE PENNSYLVANIA RAILROAD.

EXPLANATORY.

The standard passenger car color of the Pennsylvania Railroad Company, otherwise known as Tuscan red, is bought in the paste form, and the paste should contain only oil, turpentine and pigment. As a matter of fact, however, shipments always contain moisture in greater or less amount, and as both turpentine and moisture are volatile constituents, and as the amount of each has an important influence on the success of the paint, it is not sufficient to determine the sum of these two by difference, as moisture is generally determined in freight car color. Accordingly the following procedure has been devised for giving these four constituents in passenger car color:

OPERATION.

Weigh a six-ounce Erlenmeyer flask and then introduce five grams of the paste to be examined. The manipulation of the paste is not entirely easy. It is best to weigh the material into the flask, using a narrow spatula to transfer it and taking great pains to prevent any of the paste from getting on the outside of the flask, or near the top on the inside. Fill the flask about one-third full with 88 degrees Beaume gravity gasoline, and agitate with a rotary motion in a horizontal plane, until the paste is all decomposed. Now add more gasoline, and agitate in the same way to secure mixing, until the flask is about two-thirds full, and finally add gasoline from the jet of a wash bottle, so as to mix as thoroughly as possible, until the flask is nearly full. Cork loosely, without permitting the liquid to touch the cork, and allow to settle, which may require from two hours to two days. When the liquid is clear, carefully remove the cork and decant the liquid into a tall lipless beaker, which has been previously weighed, holding about nine ounces. By using sufficient care, the liquid may be decanted down so that not over five cubic centimeters are left in the flask. Some skill and a little experience are required to secure this result. Incline the flask and allow perhaps half the liquid to run out. Then, if the pigment has not already collected at the lowermost point of the flask, keep the flask inclined just enough so that the liquid will not run out, and assist the collection of the pigment at the lowermost point by striking the flask gently against the desk. If this operation roiles the liquid near the bottom of the flask, place it, still inclined, in the top of a beaker or other support, and allow to settle again, which usually takes only a short time. Then continue the decantation until the limit is reached. Place the beaker where the temperature is a little above the boiling point of the liquid and where there are no naked lights, and then fill the flask with gasoline again exactly in the manner described above. Allow to settle a second time and repeat the decantation in the same way. Enough of the liquid in the beaker will, if the evaporation is properly managed, go off while the pigment is settling the second time to furnish room for the liquid from the second decantation. Evaporate the liquid in the beaker as before, gradually raising the temperature as the liquid will bear it until a temperature of 250 degrees Fahrenheit is reached. Cool and weigh from time to time and continue the heating at the same temperature until constant weight is obtained. This weight, minus the weight of the beaker, is the weight of the oil. After the second decantation, cork the flask at once with a double perforated cork, carring two quarter inch tubes, one of which reaches to within an inch of the botton. Attach this tube by means of a rubber hose to an arrangement for passing air through concentrated oil of vitriol, and the other one to an aspirator, or any convenient suction. Pass air through the whole arrangement with occasional weighing, until the flask containing the pigment shows constant weight. Deduct from this weight the weight of the flask. The resulting figures give the weight of the pigment and they, together with the figures obtained from the beaker containing the oil, should be treated as described under "Calculations." Treat a second portion of five grams of the paste exactly in every particular as above described, except that after weighing the flask to be used with this second portion, one gram of anhydrous copper sulphate is weighed into it. This anhydrous copper sulphate takes up the moisture that is present in the five gram portion, and retains it in a condition to be weighed. The figures obtained from this flask are therefore the weight of the pigment plus the moisture plus one gram of anhydrous copper sulphate. These figures as well as those from the beaker containing the oil should also be treated as described under "Calculations."

APPARATUS AND REAGENTS.

The flasks and breakers required are perhaps sufficiently designated above.

The arrangement for taking moisture out of the air used in drying the pigment by causing it to bubble through concentrated oil of vitriol may perhaps be readily improvised in every laboratory. Drechsel's wash bottles for washing gas, with ground glass joints, are very convenient for this purpose.

The gasoline specified is readily obtained in the market. It is best to obtain it in tin cases, and every new shipment should be tested. If the same amount used in an analysis leaves a weighable residue, when a blank oil determination is made, a correction corresponding to this should of course be made. It is better, however, to secure such a grade of gasoline that no residue will be left. If the gasoline is not shipped or stored in wood or dirty cans, very little difficulty will occur.

The anhydrous copper sulphate is made by heating the ordinary crystallized salt in a porcelain dish, over a Bunsen burner, until it becomes white and pulverulent. Stirring with a glass rod facilitates the operation. High temperatures are not required.

CALCULATIONS.

The figures obtained by deducting the weight of the beaker from the constant weight of the beaker and oil give the weight of the oil in 5 grams of the paste. The figures from either 5-gram portion may be used for this calculation, as long experience shows that these figures give results which are frequently identical, and rarely differ more than a quarter of one per cent. Let us suppose the weight of oil to be 0.4340 gram. Then the percentage of oil would be ($0.4340 \times 100 \div 5$) 8.68. Still further, let us suppose that the figures obtained from the flask containing the pigment of the first portion are 3.9885 grams. Then the percentage of pigment would be ($3.9885 \times 100 + 5$) 79.77. Again, if we add together the weights of the oil and pigment obtained from the first portion, we have 4.4225 grams, which represent the weight of the oil and the dry pigment, the moisture having passed off during the drying. Adding together also the weight of the oil and the weight obtained from the flask containing the pigment of the second portion and we will have, let us say, 5.5200 grams. One gram of this is the anhydrous copper sulphate, which we added. Deducting this we have 4.5200 grams, which represents the weight of the oil, pigment and moisture of the second 5-gram portion. But from the first 5-gram portion we have the weight of the oil and dry pigment, viz., 4.4225 grams. The difference between these figures, or 0.0975 gram, represents the moisture, and its percentage would be ($0.0975 \times 100 + 5$) 1.95. Finally, the percentages of oil, pigment and moisture being known, their sum (90.40) deducted from 100 gives the percentage of turpentine, viz., 9.60.

NOTES AND PRECAUTIONS.

It is quite apparent that this method involves as its principal features the insolubility of the pigment in gasoline, the solubility of the oil and turpentine in the same menstruum, the volatility of the mixed turpentine and gasoline without vaporizing the oil or pigment, the possibility of removing the moisture from one portion of the pigment by means of dry air, and the possibility of capturing the moisture in another portion by means of the anhydrous sulphate of copper.

It is well known that commercial spirits of turpentine is rarely

free from a residue of either pitch or resin or both, which does not volatilize on exposure to dry air. This residue, of course, appears in and is weighed as oil in the method above described. The amount of this residue rarely exceeds 2 or 3 per cent., and as the maximum percentage of turpentine in the paste cannot be more than 18, the error thus introduced will at most be only a few hundredths of one per cent.

It is probable that there is a slight oxidation of the oil during the evaporation and subsequent drying to constant weight. Direct experiments on oil free from moisture, however, show that the change in weight due to this oxidation is very small. Mülder has shown that during exposure to the air, especially at high temperatures, linseed oil loses carbon and possibly hydrogen, while it gains oxygen, and experiments made for this purpose show that the loss and gain very nearly balance each other, so that the error introduced during the drying can safely be ignored.

The pigment of passenger car color gives much less difficulty from slow settling than often happens in freight car color. This is apparently due to the fact, that by the requirements of the specification, not less than 74 per cent. of the pigment must be anhydrous sesquioxide of iron, while of the remaining 26 per cent., from one-third to two-thirds may be the organic coloring matter required to produce the shade, so that there is very little space left for clay, gypsum or other hydrous substances which apparently cause most difficulty in settling.

It should be mentioned that in actual practice it is rare to obtain oil to weigh, that is absolutely free from pigment. This may arise from the fact that a little extremely finely divided pigment remains suspended in the liquid, especially before the first decantation, or from disturbance of the settled pigment during the decantation, or possibly from solution of some of the organic coloring matter in the menstruum. With proper care during the decantation the error from these causes is believed to be very small.

If the paste contains 9 per cent. of oil, as is desired and expected, the amount of oil in five grams would be 0.4500 gram. About 150 cubic centimeters of liquid is present before the first decantation, and by the supposition $\frac{5}{150}$ of this are left after the decantation is finished; that is $(0.4500 \times 5 \div 150)$ 0.0150 gram of oil is left. But if the directions are followed, $\frac{5}{150}$ of this are left after the second decantation; that is $(0.0150 \times 5 \div 150)$ 0.0005 gram of oil are left with the pigment and weighed with it. This amounts to an error of $(0.0005 \times 100 \div 5)$ 0.01 per cent. If greater accuracy than this is desired a third treatment with gasoline can be employed.

The separation of the liquid from the pigment by decantation is much better than to use a siphon. Formerly a siphon was employed, but it was found that there was a little loss due to material adhering to the siphon, and also the liquid could not be drawn off so as to leave as small a volume behind, on account of the currents at the inlet end disturbing the pigment.

The directions require that both the oil and pigment be dried until constant weight is obtained. It is probable that, especially with the oil, absolute constant weight would never be obtained. If the difference between two weighings an hour apart does not exceed one or possibly two milligrams, the resulting error will be so small, as is readily seen, as to have no practical importance.

The directions to put the paste low down in the flask during the weighing, and to prevent the liquid from touching the cork, are perhaps of more importance than would appear at first sight. The difficulty of avoiding loss while decomposing the paste, if it is near the top of the flask, is quite considerable, and the loss if the liquid touches the cork is much more than would be supposed.

Gasoline is quite sensitive to changes of temperature, and its vapor tension even at ordinary temperatures is quite considerable. If the flask is tightly corked, therefore, there is danger of loss of both flask and its contents.

There seems little doubt but that dry air will remove all hygroscopic moisture from pigment. Direct experiments made for the purpose show that after constant weight has been obtained, if water is added to the flask, and the evaporation repeated, the same constant weight is readily obtained again. Furthermore, it seems fair to consider all water not removed by dry air as a legitimate constituent of the pigment.

It should be mentioned that since the bulk of pigment in the flask is quite considerable, cases may arise where hygroscopic moisture will be mechanically held in the pigment and constant weight obtained before all the moisture has passed away. This difficulty may be avoided by distributing the pigment over the sides and bottom of the flask, just before all visible liquid disappears. The distribution is easily made by turning the flask down on its side and revolving it slowly in the hands. With a little experience the layer of pigment is easily spread over so large a surface, that the danger of entrapped moisture is very small.

The power of anhydrous copper sulphate to take up moisture is very great. If from any source, as for instance through a leaky tube, undried air is taken into the flask containing the copper sulphate, the determination is rendered worthless and must be repeated, owing to the taking of moisture by the anhydrous copper sulphate from the undried air. Numerous experiments show this beyond question. There seems, therefore, little reasonable doubt but that the anhydrous copper sulphate does actually capture and hold all the hygroscopic moisture present in the five grams of paste to which it is added. Also the necessity of preventing the accession of any considerable amount of undried air to the flask containing the anhydrous copper sulphate during the whole operation is apparent.

Experience indicates that concentrated commercial oil of vitriol used in drying the air becomes soon so diluted as to be inefficient. It must be renewed every two or three determinations. A very good arrangement is to have two or three Drechsel wash bottles, containing acid, in series, renewing from time to time the one next the flask, pushing the others down in order at each renewal.

The reason why, in getting the moisture, the sum of the oil and pigment obtained from the first portion is taken from the sum of the oil and pigment obtained from the second portion, instead of using the figures representing the pigment, in both cases, is because in this way the possible error introduced by failure to effect absolute separation of oil and pigment is avoided. If, as has already been stated, the percentages of oil obtained from the two portions differ a quarter of a per cent. with corresponding differences in the pigment, it is obvious that, if the pigment figures are used, an error to this extent would be introduced into the moisture determination, which may easily be avoided.

The Westinghouse Gas Engine.

The new gas engine which has recently been placed on the market by the Westinghouse Machine Company is the result of an extensive series of experiments. Sizes varying from 5 to 250 horse-power have been built and tested, and one of 750 horse-power is now under construction. The gas engine is believed to be fully the equivalent in design and workmanship to the steam engines by which these builders are so widely and favorably known.

In its general design the gas engine embodies the important features of the steam engine already referred to, the upright self-contained construction and the self-lubricating principle being particularly apparent. The cylinders, two in number on the smaller sizes and three on the larger sizes, are cast from a special mixture of hard, fine-grained iron, bored and finished with a high degree of accuracy. The pistons are of the trunk pattern, cast from the same quality of iron as the cylinders, and made very long in order to serve the purpose of a cross-head, without causing troublesome wear of the cylinder walls. The piston is packed with cast-iron spring rings, which insures a maximum of tightness and long life. As in the steam engines, the piston carries a case-hardened steel wrist pin, accurately ground to size, with which the upper end of the connecting rod engages. The connecting rods are forged from steel, the ends being fitted with adjustable bronze boxes lined with

the best quality of genuine babbitt metal. The adjustment of the piston end of the connecting rod, usually a difficult operation in trunk piston engines, has been taken care of in a particularly ingenious and convenient manner. The shaft is a forging made from the best quality of open-hearth steel, the cranks being forged solid and slotted out. The shaft is machined all over and is particularly strong and heavy.

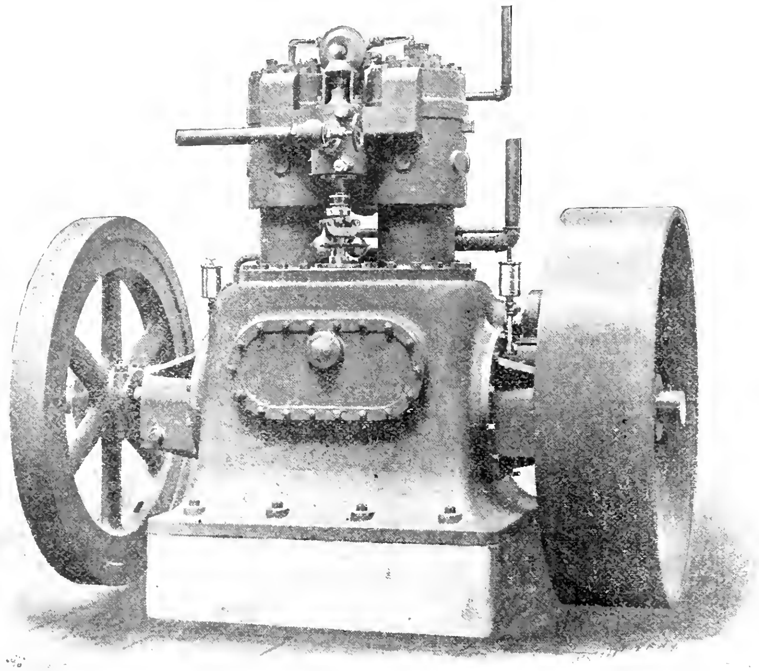
The bearings are all adjustable, the lower halves being set up by wedges operated by screws. As the wear on the bearings is always downward, the upper halves preserve their original position. In taking up the wear, the wedges are drawn across until the shaft is brought up against the upper halves of the bearings. This construction insures the proper alignment of the shaft after each adjustment, as it has of necessity to come back exactly to its original position. It also preserves the original clearances, and consequently the same degree of compression, which has much to do with the economy. Maintaining a constant height, from the base of the engine to the center of the shaft, is a specially desirable feature where the engine is connected direct to an electric generator or other machine.

The ignition of the explosive mixture is accomplished by the electric spark. The igniters are simple in construction and exceedingly durable. They are mounted in small castings, easily removed and replaced. In sizes from 15 horse-power up double igniters are provided in each cylinder. One igniter only in each cylinder is in operation at any one time, the other being held in reserve.

Small gas engines are easily set in operation by giving the fly-wheel several turns by hand until a charge of gas and air has been drawn in, compressed and exploded. In the larger sizes this method is too laborious, requiring the combined efforts of several men, besides being attended with more or less danger from the sudden starting when explosion takes place.

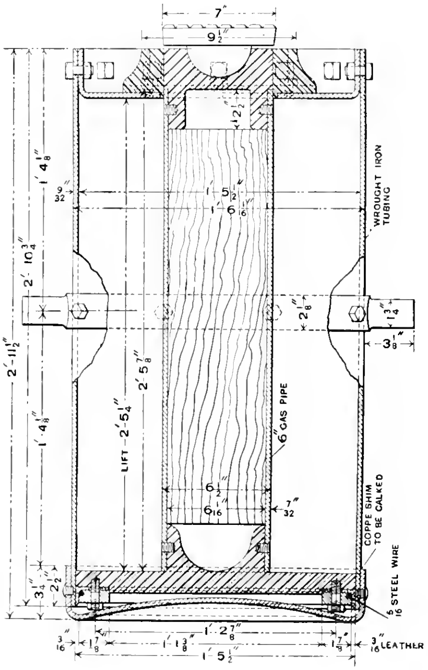
With the engines which are too large to be readily started by hand this company furnishes a simple and effective air compressor and an air storage tank of ample capacity. The air compressor can be operated by hand to charge the tank for the first time, after which it is run by a belt from any convenient pulley either on the engine itself or on the shafting. By running the compressor a few minutes every day the tank is kept fully charged and ready for starting the engine at any time. A pipe leads from the air tank to one cylinder of the engine, in which pipe is a valve arranged to be opened and closed at each revolution of the engine, by means of a cam on the end of the shaft which operates the exhaust valves, the opening occurring just as the crank is passing its upper center. A single motion of a lever on the crank case sets the exhaust valve on this cylinder so that it opens on every return stroke of the piston, instead of every other stroke, as when the engine is in normal operation. A turn of a screw throws the admission valve on the same cylinder out of operation. It will readily be seen that one cylinder of the engine is now converted into a compressed-air motor, without disturbing the functions of the other cylinder or cylinders. The engine being set with the crank a little past its upper center, the air and gas inlet valves properly adjusted, and the stop valve on the air tank opened, it starts up and continues to run on the air pressure until explosion takes place in the other cylinder. The stop valve is then closed, the inlet and exhaust valves set again to work in the regular manner, and the engine is in full operation. The air admission valve can be disengaged from its cam when not in use.

These engines operate on the Otto cycle. On the first outward stroke the piston draws in a charge of the explosive mixture, which it compresses on the return stroke. As the crank passes the center, the charge is ignited and expansion takes place on the next forward or working stroke. During the succeeding return stroke the burnt gases are expelled, leaving the cylinder ready to repeat in regular order the same series of opera-



Front View of 70 Horse-Power Westinghouse Gas Engine.

tions. The single-acting piston receives in consequence only one impulse for each four strokes, or each two revolutions of the crank. This feature at once places the single-cylinder engine at a disadvantage in the matter of steady rotative speed. The disadvantage is still further aggravated by the common "hit-and-miss" system of governing, in which the regulation is effected by varying the frequency of the explosions, leaving the intensity the same. At full load such an engine receives an impulse every second revolution, while on lighter loads the impulses may be as infrequent as one in every eight or ten revolutions. Such a method of governing cannot be either quick or sensitive, and while perhaps reasonably satisfactory when running under steady load or driving machinery in places where good regulation is not essential, it is particularly unsuited for the exacting requirements of electric lighting, especially since the advent of high efficiency lamps, on which the effect of bad regulation is disastrous. This shortcoming is compensated for, in a measure, by

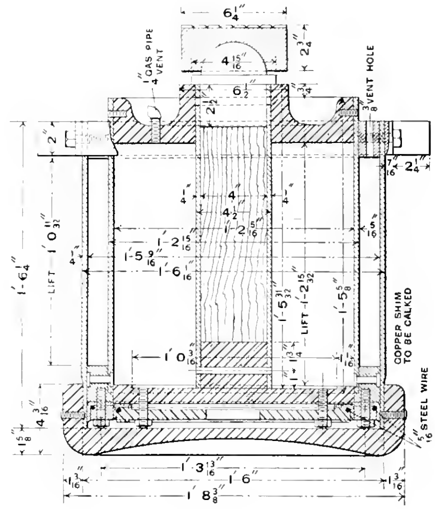


the use of extraordinarily heavy flywheels on the engine itself, often supplemented by auxiliary flywheels on a jack shaft or on the shaft of the dynamo. Even with the greatest precautions, the explosions in the engine can often be counted by the changing brilliancy of the lamps in circuit, and always by fluctuations shown by a reasonably sensitive voltmeter.

By the use of two cylinders alternating the working strokes of the pistons the Westinghouse gas engine receives an impulse at every revolution. A sensitive governor regulates the amount of the explosive mixture admitted for each charge, in proportion to the load on the engine, giving an impulse at every revolution whether running fully loaded or entirely light. On this account, for smooth running and steady speed, it is said to be equaled only by the best steam engines, and these essential and desirable qualities are obtained without overloading the shaft with enormous flywheels. This claim is substantiated by the fact that these engines have been successfully operated when connected direct to dynamos.

Pneumatic Jacks for Lifting Locomotives.

In locomotive repair shops not equipped with overhead traveling cranes portable power jacks for such work as lifting locomotives while taking out or putting in driving wheels are very convenient and the accompanying engravings show a design for this purpose as worked out and used by Mr. J. H. McConnell, Superintendent of Motor Power of the Union Pacific Railway. These appliances are not new in principle, but the application of compressed air to the lifting of such heavy weights is interesting, as is also the telescopic feature of one of the pair of jacks shown. The single lift jack has but one piston and lifts 29¼ inches. It is used under the rear end of the engine and the telescopic jack is used under the front end. The larger piston of this jack has a lift of 12 inches and the smaller piston lifts nearly 15 inches more. Wrought-iron tubing is used for the cylinders and piston rods and the packing for the pistons is of leather turned over rings of wire $\frac{5}{16}$ inch in diameter. There are four castings in the telescopic form, one of them being the base casting and in the single lift jack the base is made of pressed plate. Both jacks are designated as 17½ inches in diameter. A convenient form of two-wheel truck constructed of iron with a wooden tongue is provided for transporting each jack and they are operated by



one man exclusively. The engravings show the trunnions used for carrying the jacks about. The air pressure is applied by means of a pipe leading from the base of the jack to an ordinary hose coupling for attachment to the shop air hose. Mr. McConnell states that they have been found much superior to ordinary ratchet jacks and it is easy to see that they afford a means for a great saving in time in making the lifts. The engravings do not appear to require further explanation, except to call attention to the wooden filling of the piston rods.

Master Car and Locomotive Painters' Association.

The twenty-eighth annual meeting of the association will be held at Old Point Comfort, Va., Sept. 8, 9 and 10, at the Hygeia Hotel. A special rate of $3 per day has been secured for members and their wives. The list of subjects for discussion is interesting and an instructive meeting is expected. Mr. Robert McKeon is Secretary of the Association with office at Kent, O.

The Great Siberian Railroad and the Present State of Its Construction.

(Special Correspondence to the *American Engineer, Car Builder and Railroad Journal.*)

(CONTINUED FROM PAGE 234.)

THE EASTERN SIBERIAN OR AMOUR RAILROAD.

The surveys of the line connecting the Acriminus of Transbaikal Railroad with the Oussouri Railroad, along the left shore of Amour River, were very difficult: $500,000 was appropriated for that purpose. The surveys were begun in 1894 and ended in 1896. They gave the following results: The length of the line from Pokrovska to Khabarovk will be 870 miles, and the cost together with rolling stock $50,125,000, or $57,610 per mile.

The construction of this line will be postponed to an indefinite time, for it is found more convenient to connect the Transbaikal line with the Oussiri line or rather with a point of it near Vladivostok by means of a line located in a great part across China. This new line the Eastern Siberian Railroad planned to extend from the station Onon of Transbaikal Railroad to Station Nikolskoie of Oussouri Railroad, 1,280 miles long, consists of three sections: 1st, the branch of Transbaikal Railroad, from Onon to the China boundary, 293 miles; 2d, the Eastern China Railroad, 920 miles, across the two China provinces; Khei-lun czian and Ghirin, and 3d, the Oussouri branch, 67 miles from the China boundary to Station Nikolskoie. Both branches will be constructed by the Russian government; the Eastern China Railroad will be constructed in five years by the company of the Eastern China Railroad, incorporated by the China-Russian bank, and being under the control of Russian Finance Minister.

On the line of the Eastern China Railroad only reconnaissances and topographic surveys along the designed direction were made in 1896. The definite location will be determined in 1897, and the construction will be commenced in August of this year.

It is obvious from the above that the railroad line along the left shore of Amour will not be built, and so the Amour territory will remain without any high way, having as yet not even a wheel road across it. Therefore the construction of a highway along the left shore of Armour will have great importance for the country. Such a road is projected by the Minister of Ways and Communications; it will be 850 miles long and cost about $5,500,000. It is designed with gradients not more than five per cent., with radius of curves 175 and 105 feet, with grade 21 feet wide (14 feet macadamized), with timber bridges and post station houses.

This highway will be located in the direction chosen for the intended Amour Railroad.

THE OUSSOURI RAILROAD.

The Oussouri Railroad, from Vladivostok, on the Pacific Ocean, to Khabarovsk, is 479 miles long. It consists of two divisions:

I. The South Oussouri Railroad, from Vladovostok to Grafskaia, 227 miles long, with three miles of branches. It was begun in 1891 and is now quite ready, and has cost $10,290,000, or $49,000 per mile.

II. The North Oussouri Railroad, from Grafskaia to Khabarovsk, 252 miles long, with 3½ miles of branches. It was begun in 1894 and will be completed in 1898. The cost of it is estimated at $10,855,000, or $43,000 per mile.

The South Oussouri Railroad has been damaged very much by the inundations of 1895 and 1896; so that the reconstruction of grading and bridges requires $550,000.

The state of construction of the North Oussouri Railroad is given by following figures: The clearing is completed; grubbing is 73 per cent. done; 227 miles of temporary roads are ready. Earthworks on the main line: 6,261,000 cubic yards or 90 per cent. of the whole, is made; on the Amour harbor 30 per cent., on the Amour branch 74 per cent.; on stone culverts and small bridges 91 per cent. of stone work is made; 50 per cent. of iron girder are erected; 98 per cent. of timber bridges are finished. Of the great bridges across the rivers Iman, Bikin and Khor, about 50 per cent. of stone work is done, and of 11 caissons, 5 are sunk and 1 is under construction; of 9 spans of 210 feet each, 4 spans are erected and 3 have been carried from European Russia. The track is laid on 101 miles of main line and 8 miles of branches, and 9 miles of station sidings; 580,000 ties are prepared, and 240,000 ties are already laid in track. The telegraph is built on 90 miles. Of line buildings, 21 section houses, and 25 small section houses are ready; besides them on 10 stations the passenger houses and all other buildings are building.

The construction of the Oussouri Railroad goes slowly in consequence of very difficult local conditions. In 1896 two inundations and a very rainy summer and autumn (15 rainy days a month) obstructed the progress of work. The population is very small, and the cold and dry winter and hot and moist summer, together with marshy ground, generate many chills, rheumatic and fever sicknesses.

The Oussouri Railroad was that link of the Siberian Railroad which was begun in 1891, the commencement of construction being inaugurated by the Csarevitch Nicolas (now Emperor). The provisory traffic was opened in sections in 1893 and 1894, and has given the following gross receipts for freights and passengers:

In 1893 year from November 1	25,453 roubles.
" 1894 " " " "	262,253 "
" 1895 " " " "	799,355 "
" 1896 " till October 1	654,106 "
Total	1,741,167 "

THE VLADIVOSTOK PORT.

The Vladivostok is the eastern terminus of the Great Siberian Railroad, and therefore it will have a well-equipped commercial port. To that purpose the bay of "Golden Corn" in the south bank of peninsula Monravier Amourski can be utilized. This bay situated on 43° 6′ 51½″ of northern latitude and 149° 36′ eastern longitude is about 3 miles long and 1 mile wide, and has a depth varying from 26 to 66 feet, and is protected against all winds. However, in winter the bay is covered with ice, but this defect can be met by means of two or three ice breaking steamers.

For fitting this port a landing harbor 2,100 feet long is designed, which shall lessen the cost of landing, this now being about $1½ per ton. The cost of this construction is estimated at $635,000.

THE AMOUR RIVER.

The construction of the link connecting the Transbaikal Railroad with the Oussouri Railroad will not be completed until 1903, and if the other lines are completed in 1898, then from 1898 till 1903 the Amour River from Sretensk to Khabarovsk will be the important connecting link of the Great Siberian route. The navigation on this portion of the Amour (Sretensk-Khabarovsk) begins in May and ends in the middle of September; the navigation on Oussouri River continues from the middle of April to the middle of October; the steamers, after the winter stay, start about the middle of May from Nicolaievsk, the estuary of the Amour. A good navigable year has only 170 days. The navigation in the lower and middle part of the Amour (about 1,300 miles), up to Blagoveshchensk, is quite convenient and open during the whole period. From Bagloveshchensk to Pokvovska the navigation on Amour and further to Sretensk the navigation on its tributary, Shilka, is not so easy, and sometimes in low water must be suspended entirely, the depth in some spots being only 2½ feet. The commercial fleet on the Amour consists of 100 steamers with engines of 4,500 indicated horse-power, and about 200 barges with a tonnage of 17000.

This number of steamers and barges being not sufficient for the transportation of the materials destined for the construction of Siberian railroad, the government has ordered two side-paddle tug steamers for the Amour: one of 600 indicated horse-power and another 900 indicated horse-power, and seven steel barges, each with a carrying capacity of 400 tons. In this manner only the transportation of materials and the terms of construction of the Siberian Railroad can be obtained.

GENERAL REMARKS.

The above statements show that in the years 1895 and 1896 the construction of the Great Siberian Railroad was carried on with an uncompared energy, as is obvious from the following figures, showing the progress of tracklaying:

The length of track at the close of 1893 was	257 miles.
" " " " 1894 was	885 "
" " " " 1895 was	1,808 "
" " " " 1896 was	1,990 "

If we compare the latter figure with the total length of the Great Siberian Railroad from Chelabinsk to Vladivostok, 4,507 miles, we see that the track is already laid on nearly the half of the main Siberian Railroad. On the other side, comparing the length of the continuous railroads, old and new ones, opened for traffic from St. Petersburg to Krasnoiarsk, 3,070 miles, with the total distance from St. Petersburg to Vladivostok, about 6,232 miles, we find that the half of this distance can already be traveled by rail.

A. ZDZARSKI.

Thirty years ago the B. & O. bought steel rails in England at a cost of $112 per ton in gold. Some of this rail is still in use on short branches and is in marvelously good condition. It is pear-shaped and was intended for use with wooden splices.

Communications.

Railroad Testing Bureaus.

August 6, 1897.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

Before I had read the article in the August number of your paper on the subject of "Railroad Testing Bureaus" I had made a memorandum to write you with the request that you take up this question of laboratories for the purpose of ventilating it a little. The subject will probably be discussed at the convention next year, but I cannot wait to express my disapproval of any plan looking to the entering of such a field by the Master Mechanics' Association, and cannot believe the Master Car Builders will seriously consider the idea of going so far out of their way. Before I had a laboratory in my department I found it very convenient and entirely satisfactory to have testing done by one of the regular testing bureaus, and I am not sure now that it would not be money in our pockets to continue in that way. I think that the railway associations have no business to establish laboratories for routine work. The various testing bureaus or private concerns engaged in this business can do it more cheaply and more satisfactorily for such roads as cannot maintain laboratories of their own. Regarding the special work for which you conclude a laboratory or laboratories established at central points would be feasible I would say that the idea seemed to me to be a good one if there is work enough to keep such a laboratory going. I think, however, that there should be only one such laboratory in the country maintained by the association, as there would certainly not be enough work to keep more than one busy. Such a laboratory should include a dynamometer car, a stationary testing plant and facilities for making such tests as those by the committee on best metal for brakeshoes. Such a laboratory might be started in a modest way and added to as the necessities appear. I heartily approve of this part of the idea if it is not overdone.

MASTER MECHANIC.

Lubrication of Locomotive Cylinders.

RIO CLARO, BRAZIL, July 8, 1897.

EDITOR OF THE AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL.

Will you allow me to say that I cannot agree with the writer of the article on lubrication of locomotive cylinders in your June number, either as to the cause of the trouble now being experienced or the remedy therefor? I do not believe that condensed steam accumulates in the oil pipes at any time if the instructions of the lubricator companies are followed in giving these pipes a constant descent from lubricator to steam-chests. Water will always run down hill, and there is nothing to prevent these pipes draining themselves after the pressure has equalized, if there are no sags. This, however, is what I believe *does* take place.

After the drops of oil have passed up through the water in sight feed glasses they are blown into the oil pipes by the steam through the pin holes in the choke plugs, and by this process the oil is thoroughly atomized. If the throttle is closed this steam expands after passing the choke plugs, and makes a sufficient volume to create a current strong enough to carry this oil through to the steam chests in its atomized state. Now, if the throttle is opened, the pressure from the steam chests rushes up into these pipes, forcing this expanded and oil-laden steam before it until the pressure is equalized, and the pipes are swept clean of oil for a considerable distance. After the pressure has equalized, the current again sets toward the steam chests. But the small amount of steam that can pass through the pin hole in the choke plugs, not being allowed to increase its volume by expansion as before, in consequence of the pressure from below, does not make enough current to carry the oil along in its atomized state: instead of which, this oil adheres to the surface of the pipes, then collects in drops, and finally after a considerable time accumulates in a sufficient quantity to run to the steam chests by gravity, assisted somewhat of course by the feeble current in pipes. Any reduction of pressure in the steam chests causes the steam in pipes to expand and rush out, bringing the accumulated oil with it, and then we must wait for it to collect again as before. This, of course, gives a very irregular feed to valves while the engine is working steam.

Enlarging the pipes would, I should think, aggravate the evil, as it would present more surface for the oil to collect upon, and also further decrease the velocity of the current. If any change is to be made, I think the pipes should be made smaller. The devices spoken of as being applied by the lubricator manufacturers, to automatically let a larger volume of steam into the pipes, at or near the lubricator, would seem to me to be the best way out of the trouble, although, as is stated, this makes a complication that should be avoided if possible. If an engine were left standing with closed cylinder cocks, sufficient pressure might accumulate in the steam chests to open these automatic valves and cause the engine to move off at an awkward time. The question would seem to be, whether the evils now complained of are grave enough to justify this complication and its attendant danger.

I cannot see how anything would be gained by using the falling drop lubricator. There is no difficulty now in getting the oil into the pipes: the trouble is in getting it through them. The distance which a locomotive lubricator must be situated from the point where oil is required is such, that gravity alone cannot be depended on to do this satisfactorily, when so small a quantity is to be fed at a time. I have, no doubt, however, that lubricator manufacturers, now that their attention has been so generally called to this difficulty, will meet and overcome it in the best possible manner.

C. L. DUNBAR.

[A great deal may be said upon this subject, but we are disposed to await the results of some careful experiments now being conducted by the officers of a large road before putting forth any more statements which are not based upon absolute knowledge of what goes on inside the pipes of locomotive lubricator systems. We believe our correspondent to be wrong, but are unable to prove it now. When the tests referred to are completed more will be said upon the subject.—EDITOR.]

The Strong Balanced Locomotive.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

Again the old subject of the hammer blow is brought to our notice: this time in a slightly different light. At one time the "hammer blow fiend" got to be such a nuisance that threats of annihilation seem to have prevented the term being used in connection with recent tests at Purdue University, but notwithstanding the idea still remains like the fellow who thought "damn" if he could not say it. There is not a particle of doubt but that the Strong locomotive can be balanced both vertically and horizontally, but we do not think that the game is worth the candle, in the fact that not only is the vital machinery of a locomotive doubled but the very uncertain crank angles are also introduced. Professor Goss' tests show what every engineer knew before would be the result of this arrangement, that the wheels would turn smoothly at all speeds and if this is the whole intent of the builders; the locomotive will undoubtedly be a success in that particular, as there would be no excess balance in the wheels and probably no tendency to "nose" on the part of the engine.

Mr. Strong's letter in the *Railroad Gazette*, dated Aug. 9, says in one place: "The heavy pistons and weight of the reciprocating parts make the use and ownership of such engines too expensive." The remedy that is proposed in this engine seems to me like an antidote for a poison, instead of getting down to bed rock and eliminating the poison altogether. While it is true that the inertia of one piston with its piston rod, crosshead and connecting rod moving in one direction, is balanced and counterbalanced by its fellow piston, piston rod, crosshead and connecting rod moving in the opposite direction, yet it is nowise true that the inertia of the parts has been eliminated; in fact, not only do we have the inertia of one set of piston and attachments, but we have double the effects caused by its fellow pisston and attachments. It is true that the individual parts can be made possibly lighter than when the same power is obtained from a single piston, but there will certainly be more weight in the two sets of pistons, etc., than when the same power is doubled with one piston, and while the thrust of the inertia is distributed over a greater amount of bearing surface, yet it is still there, and will make itself felt in wear on journals, bearings, etc. In June, 1896, the undersigned presented a paper on "Locomotive Counterbalancing," before the

Association of Engineers of Virginia, in which he recommended that the amount of unbalanced reciprocating weight for one side of the engine be taken at $\frac{1}{360}$ of the whole weight of the engine in working order. About the same time the Committee of the Master Mechanics' Association recommended $\frac{1}{400}$ for this value, but Mr. E. M. Herr, the Chairman of that Committee since stated that he believed $\frac{1}{360}$ was just as good as $\frac{1}{400}$, and judging from the very steady and easy riding of a locomotive recently redesigned and whose unbalanced reciprocating weight is $\frac{1}{342}$ of the total weight of the engine, it seems to be evident that the excess balance may, with proper designing, be gotten down to a very small figure. The engine referred to has 20-inch cylinders, 68-inch driving wheels and operates with 180 pounds steam pressure, from which it will be seen that a strong piston and connection is necessary, but for this engine we have the following reciprocating weights:

1 Piston and rod	308	pounds.
1 Crosshead	183	"
48 per cent. of main rod	205	"
Total	696	"

This, we think, is very light for this size of engine. The counter-balances in this engine appear to the eye to be very light and, in fact, the pressure in a vertical direction due to excess balance in the wheels, amounts to but 4,000 pounds per wheel at a speed of 68 miles per hour, and as the load on each wheel (not axle) averages 16,000 pounds, it will be seen that the effect due to the excess balance is very small. It is true that there are many engines running in which the effect of the excess balance at high speeds would be as great as the static load on the wheel, but we must file a disclaimer that these engines should be considered a good design as far as this detail is concerned.

From the sbove facts we believe that a two-cylinder engine, simple or compound, can be so designed that the reciprocating weights and excess balance in the wheels will in no wise be detrimental to the operation of the engine or the track, and without necessitating the extra care which double pistons, crossheads, guides, connecting rods and cranks is sure to result in, and we are confident that this opinion will be sustained by 99 per cent. of the practical railroad men in this country.

Only a few years since, one of our oldest authorities on locomotives recommended a pendulum motion from the crosshead by which a weight equal to the piston, etc., should be swung in the opposite direction by a system of levers, and while this was much laughed at and discussed at the time, yet we believe in the long run it would be preferable to doubling up our pistons, crossheads and connecting rods. G. R. HENDERSON.

ROANOKE, VA., Aug. 20, 1897.

Why Automatic Road Crossing Signaling Apparatus Fails.

BY V. K. SPICER, MEM. AM. SOC. C. E.

The question of protection to people and vehicles at crossings of highways and railroads has occupied much thought, and many devices for the purpose have been employed with greater or less success. Gates operated by men stationed at the crossings are most frequently used to afford such protection.

A man armed with a flag, or lantern, having authority to arrest the progress of passengers, even if he is vigilant, can afford but limited protection. Supplemented by the most effective gates, his actual duties are increased, his attention distracted and his ideas of responsibility reduced, from the fact the gates under his manipulation are intended to warn against and prevent passage across the tracks. It is practically impossible to impose and operate any sort of physical barrier against the foolhardy passenger that will be effective and economical.

In order that ample warning of the approach of trains shall be given, not only to a crossing watchman when one is employed, but to all who may be in the vicinity of the crossing, visible and audible indications must be exhibited at the proper time, and continue in evidence until the passage across the tracks is again safely open. Without such warnings, a watchman has no accurate knowledge of the approach of trains during foggy or stormy weather, or when his sight or hearing is obscured. With a thoroughly reliable arrangement of this sort, the best possible protection can be offered to the public at ordinary highway crossings.

"Self preservation is the first law of nature," and a warning of danger, given in ample time, in a way which will allow the faculties to act without restraint, will be more effective than anything else to prevent accidents of every sort. Since the human being only is capable of fine reasoning and it is for him that the warning is offered, a sign and a sound—a visible and audible signal—produced at the right time and place, cannot but be effective for the purpose, and this gives the automatic signal its strong recommendations for crossing protection.

This indication, however, must be absolutely reliable; not only must it never fail to act for the purpose for which it is designed, but it must never give a false alarm. The cry of "Wolf, Wolf!" when there is no wolf, invariably leads to despising the animal. A crossing alarm bell that rings for any other cause than that for which it is intended is a greater menace than no bell at all. Curiosity on the part of the average passenger leads him to observe any irregularities. Arriving at the crossing and hearing the bell ringing he naturally stops and waits for the supposed train to pass. Finding that there is no train he will make some disparaging remarks and proceed on to the crossing, keeping an eye on the bell rather than on the track. On the other hand a bell that fails to ring at the proper time serves to cast discredit on the system, so that the passenger is taught to take chances and the danger is increased.

Of the many automatic devices made and applied for the protection of highway crossings at grade, there are some which are as nearly perfect as it is possible to desire. That they usually fail to give satisfactory results is not attributable to any inherent imperfections of the design or construction, but almost entirely to the fact that they are not maintained with the necessary amount of intelligence and care, after they have been applied and turned over to the railroads. In order that a watch shall keep perfect time, it must be regularly wound. It must be inspected, cleaned and regulated. Most railroad companies retain a regular watch inspector and require their employees to not only possess a standard watch, but to have it examined at stated periods and a certificate of inspection secured. Only under similar conditions can accuracy in any department of a railroad be insured. The signals, however, seldom have a corresponding degree of care. Telegraph systems are efficient at the expense of a head of the department with his numerous assistants who are all expert in their particular lines. It is not reasonable to expect that an engine runner can despatch trains from a telegraph instrument any more than that a lineman should be able to repair a locomotive; and yet it is common to find telegraph men held responsible for signals, which is equally inappropriate.

If the telegraph department is employed and the duties assigned to a certain number of men, almost always the fewest that can possibly be made to do the work, and they are expert in their particular vocations, the imposition of special, additional duties on these men, especially if no extra compensation is given, must result in neglect to some of them. A lineman has the care and repair of a certain section of pole line and the instruments with their accessories. He must be on the constant look out for "trouble," which may occur at any moment on any part of the line. His first duty is to go to that point at once. The line is long, the stations many and many hours are necessarily spent in traveling. He is human and is naturally eager to get home at the end of the day. Trains are not frequent, and he is obliged to catch the most convenient ones for his purpose. This gives him a limited time in which to examine and repair the apparatus under his charge, and if he does not succeed in doing so at the right time, he usually fixes it up in "good-enough-for-the-present" shape and leaves it until the next day. Meanwhile, perhaps a storm causes damage in another place, and he is obliged to go there at once, and the incomplete work waits. The common practice among railroad companies of putting all sorts of apparatus involving electrical devices under the care of the telegraph department has not only overburdened this department, but has resulted, with but few exceptions, very unsatisfactorily. Bells and signals for the protection of highway crossings, where these are automatic, involve electrical devices in their construction. They are not necessarily complicated and need not demand particularly expert care. They must, however, be regularly inspected by a man competent to understand their requirements and they must be kept in repair and in correct adjustment, just as a watch, or a locomotive, or any other apparatus must be, if satisfactory results are to be attained. Unless this can be done, there is infinitely greater safety to the public and saving of money to the railroads, in the ordinary cheap signboard which announces to all who may read: "Look out for the engine when the bell rings."

Railroad companies generally go to great expense to inclose their rights of way. They have encouraged inventors in their efforts to perfect apparatus for these purposes by offering facilities and opportunities for testing their inventions in practical service on the lines, holding out the assurance that, if satisfactory in operation and price, they would purchase. The weak point in almost every invention has been the lack of knowledge, on the part of the inventors, of the circumstances existing on the railroads. Where these have been successfully met, the failures to

the satisfactory operation of the devices have been due almost entirely to the fact that the railroad companies have not employed proper men to maintain them. The word "automatic" attached to signaling apparatus seems to imply to the average railroad man that it is self-sustaining as well as self-operating. This is a most serious mistake.

For example, consider the automatic rail circuit system in connection with block signaling, operating highway crossing bells, switch and bridge locks, locks on interlocking levers and a variety of other devices. The track circuit, in order that it shall be effectively established, demands that every rail joint shall be bonded with wires; that the block sections shall be separated, electrically, from their neighboring block sections by insulated joints; that the batteries shall be set up and connected by substantial conductors properly protected and connected to the rails; that the relay or electrical instruments shall be protected from harm and interference, in order that they shall be operative. The rails, joints, ties and roadbed are kept in condition for traffic by a gang of men whose chief duty this is. It is customary to require these men to look after the track attachments of signals also. They are familiar with ordinary work of the track and have more or less of a standard by which to work. They know when a rail joint needs lining, tightening or renewing. They know where, when and how spikes must be driven. Their duties require that the track shall be in good condition for the passage of trains, clearing the roadbeds of weeds, dressing ballast, renewing ties and many other incidental matters are left for such times as they are not thus employed. Bond wires, track insulations, connections to batteries and similar attachments, where such exist on a section, are constantly passing under their eyes. They have an indistinct idea of their purpose and importance and have received orders to care for them. The apparent mystery of the thing stands in the way of intelligently doing this and, together with the weeds, ballast and other things they, like the telegraph men, put off the signals for a more convenient time until matters have long gone wrong. They have their regular duties and are subject to special call orders. As a rule they are the least intelligent, worst paid employees and it is unreasonable to expect them to understand the simplest details of signaling apparatus and the accessories entering into the track department.

The various parts of signal apparatus are simple in themselves, but they each form a link in a chain, and one defective factor spoils the whole. The automatic signal never fails without reason, and a broken link due to neglect is usually the reason. The remedy lies in treating the subject with the same degree of care and watchfulness as is devoted to the other important factors which go to make up a safe railroad. Let us ask how often locomotives are inspected, and how about bridges and rock cuts along the line? We are at present limiting ourselves to crossing signal apparatus, which is but a small part of the whole department of automatic signaling, but very serious accidents may occur at crossings, and a special reason for the most careful maintenance of such devices lies in the fact that it is very difficult to prove that the apparatus worked properly at the time of an accident. Frequent inspection and constant care are the price to be paid for the best evidence that is to be had that the instruments were doing their duty, and this will also tend to render occasions for such evidence less frequent.

Staybolts Broken and Partially Broken.

Among the noon-hour topical discussions at the recent Master Mechanics' convention was one upon Broken Staybolts, which was introduced by Mr. T. A. Lawes, Superintendent of Motive Power of the C. & E. I. Railroad with the following remarks, which form the basis of another article upon the same subject presented elsewhere in this issue:

Under the presumption that you will readily grant me permission to qualify the phrase, I shall be pleased to present to you a few thoughts on the subject of "Partially Broken Staybolts," which, in my opinion, is a topic of much greater importance, since partially broken staybolts are the more difficult to detect. In fact, so far as my investigation goes, they are never detected under the old methods, and must be regarded with suspicion.

For some years hollow staybolts and drilled staybolts have been used to a limited extent, but for some reason—or no reason—neither one has been put into general use, although, as I believe, the protection afforded is invaluable.

To satisfy myself as to an inspector's ability to detect broken and partially broken staybolts, I have had the staybolts in 13 engines drilled during the past year. The plan adopted was to have the inspector locate all the broken staybolts he could find, after which the staybolts in the firebox were drilled, including those marked by the inspector as broken. In the first firebox tested in this manner the inspector found 39 broken staybolts. After drilling and testing under water pressure these were all found broken—and in addition to these we found 59 others broken which the inspector was unable to detect by the hammer test. This surprising result led me to examine the broken staybolts critically, and I found that those detected by the hammer test were broken entirely off, while those found by drilling holes in the ends were only partially broken off.

After testing the stay-bolts in 12 fireboxes and finding the ratio of broken staybolts and partially broken staybolts about the same as in the first firebox tested, I concluded to try the method of testing under boiler pressure, and having a helper hold on while the inspector gave the hammer test, but with no better results.

I desire now to direct your particular attention to the 13th and last firebox tested for broken and partially broken staybolts by the two methods. I consider it the most severe comparative test of all, from the fact that three inspectors in turn did their level best to locate broken and partially broken staybolts by the hammer test, they having been informed that the staybolts were to be drilled after they were through with their inspection. They were given all the time they required to make a careful and accurate inspection. The result was that the hammer test located four broken staybolts and the drilling test discovered 46 partially broken.

A careful record of the broken and partially broken bolts detected in 13 engines shows that 440 were discovered by the hammer test, and 619 by the drilling test.

To me these facts are conclusive evidence that partially broken staybolts cannot be detected by the hammer test, and I believe a great risk is run by either not drilling the ends or not using hollow staybolts, and that either of these precautions will prevent many boiler explosions with the usual verdict of "Cause of explosion unknown."

There have been more boiler explosions in recent years caused by broken staybolts than ever before. I attribute this to the fact that a much higher pressure is carried. Too great precaution cannot be taken to prevent loss of life and destruction of property, and my experience leads me to recommend that every staybolt used should be either hollow or drilled, making it self-detecting.

The expense of the precautions here recommended should not stand in the way of preventing boiler explosions due to defective staybolts, as the cost for drilling is only about $3.75 for a firebox containing 900 staybolts. I figure that the cost is only an apparent one.

For example: If the 619 partially broken staybolts had not been drilled and tested in the 13 fireboxes referred to above, these partially broken staybolts in time would have become broken staybolts, and the engines containing them would have to be laid up—possibly when needed badly—for the removal of broken staybolts, which would have necessitated the removal of jackets, air brakes, pumps, frame angle iron and other parts covering the staybolts, thus causing an additional expense over that, if properly attended to in the shop while undergoing repairs.

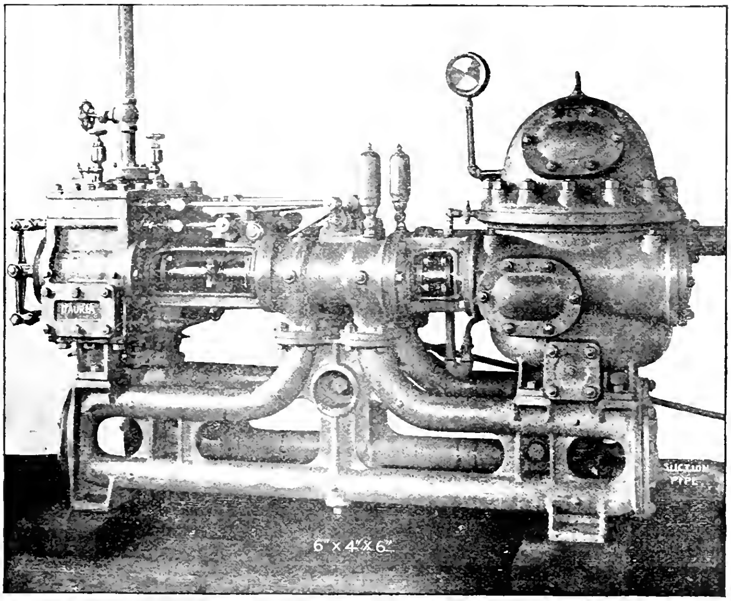
It is my practice to turn engines out of shop with staybolts beyond suspicion, and I find that I have no trouble with them afterward. I recommend to such members of the association as do not use hollow or drilled staybolts, that they drill the staybolts in a few fireboxes as described and keep a record of the number found by the hammer test and by drilling them, and I am sure that they will be surprised at the results.

The d'Auria Pumping Engine.

The problem of working steam pumps which are not fitted with heavy flywheels in a way permitting of using steam expansively has proved itself a troublesome one and the new pump shown in the accompanying engraving is brought to our attention with strong claims for the economical use of steam. The design is due to Mr. Luigi d'Auria and is described in a circular by the d'Auria Pumping Engine Co., from which the following information is taken:

Cut-off valves are used to secure the expansion of the steam in both simple and compound types. The expansion is made possible by an exceedingly simple and ingenious compensating device which adds nothing to the working parts of the pump that is at all likely to give trouble in operation. This device consists mainly of a liquid column contained in a closed loop of pipe extending from the ends of a chamber in which a piston or plunger is fitted and carried by the same rod upon which the steam piston and the

pump plunger are attached; so that when the latter are set in motion by the action of the steam, the liquid column is forced to reciprocate with them. This liquid column then acts as a balance wheel, controlling the speed of the piston, and producing a smoothness of action stated to be comparable only with that of the best crank and fly-wheel pumping engines. Pendulum-like the reciprocating parts are brought to rest by the gradual expending of their energy while doing useful work. Any excess of energy at the end of the stroke is safely absorbed by steam cushioning, lengthing the stroke somewhat, and filling the clearance space with steam of high pressure ready to do work in the return stroke. A very simple by-pass, made in the piston or plunger which reciprocates the liquid column, absolutely prevents the steam piston from striking against the cylinder-head. In case of a sudden release of pressure upon the pump, caused by a break in the main, a safety device is provided which throttles the liquid column of the compensating device and transforms the latter into a sort of cataract, checking at once the speed of the engine; and as the safety attachment closes the steam throttle at the same time, the engine is brought to rest before it can possibly reach the end of the stroke. Of course, this attachment is only required in large pumping engines. In smaller ones, the engine takes care of itself without it, the steam cushioning and by-pass being quite sufficient to prevent striking under any circumstances. The pipe containing the compensating and controlling liquid column is so designed as to form a bed plate for the engine and pump. With this bed plate it is said that the pumping engine can be placed on any floor and run without being fastened to it. The admission and cut-off valves are plain slides connected to their stems and rock shafts, without lost motion.



The d'Auria Pumping Engine.

The circular is authority for the statement that the engine shown in the engraving, a 6 by 4 by 6-inch non-condensing engine gave a duty of 26,200,000 foot pounds, corresponding to 76.6 pounds of steam per pump horse power per hour, the pump developing 6.87 horse power. This result with such a small pump is remarkable, especially when it is considered that the pump was new when tested, not having been under steam over one day altogether. The claim is based upon this test that a simple, seven horse power d'Auria pumping engine uses steam as economically as an 80 horse power compound pumping engine of the ordinary duplex type. The construction of a larger equipment is now under way, and as the saving of steam means a smaller investment in boiler plant as well as in fuel, the new design appears to be what hydraulic engineers have been in search of for years.

Rope Driving.

At a recent meeting of the Birmingham Association of Mechanical Engineers (England), Mr Geo. H. Kenyon, of Dukinfield, read a paper on "Ropes and Rope Driving." Mr. Kenyon said that for all practical purposes rope transmission may be regarded as positive, all things considered, and in making calculations for speeds the supposition that slipping and consequent diminution of speed must of necessity enter into the equation may be dismissed as scarcely worth consideration. The elasticity of rope driving was of supreme importance; the ropes themselves were very sensitive to any irregularity, and acted as a buffer between the initial and ultimate power, making back lashing (the bane of gear driving) an unknown quantity. There were many points to be observed and enforced before the high-tide mark of efficiency may be reached. First and foremost was the construction of the groove, the most effective style being that with straight sides resting at an angle of about 10 per cent., and of sufficient depth to prevent the rope reaching the bottom or the curve with which the rope terminates. On no account should grooves with curved sides be used, as it is impossible for ropes to bed themselves, and they become restless and roll round in the attempt. It is generally acknowledged that ropes should never be run upon pulleys of less than 30 times their own diameter. Although good cotton ropes will coil in considerably less compass, yet it is always wise not to go below this limit, and err, if at all, in the direction of large-size pulleys, as the repeated effort of compression and extension produces what is well expressed as "fatigue" material when the elasticity is worked out. The best results may be anticipated when the smallest pulley is 50 times the diameter of the rope. In his opinion it was always advisable to consult with a thoroughly practical engineer respecting power transmission before submitting any scheme for the erection of electrical installations. Whatever new material may be discovered in the future—and several new fibres had recently been experimented with—he knew of none which even approached, let alone superseded, cotton for the purpose of rope driving; for it was strong, durable and pliant, yielding readily to the shape of both pulley and groove, and quickly recovering its normal tension after every wrench and strain. He submitted a sample of cotton rope that had been running for 11 years at the rate of 20 hours per day, and which was as good as ever.

The Railway Signaling Club.

The next regular meeting of the Railway Signaling Club will be held at the Grand Union Hotel in New York City on Sept. 14, 1897, at 4 o'clock P. M. The discussion of a paper by Mr. H. M. Sperry, entitled "Some Signal Problems" will be held. A committee report on Battery Tests will be read; and a paper by Mr. Charles Hansel on "A Moral and Physical Agent in Safe Railway Travel" will be presented.

As this meeting is the first one to be held outside of Chicago, it should be the earnest desire of every member to make it a success. The Lehigh Valley Railroad has extended an invitation to the club to take a trip to Easton from New York and return, on a special car, which has been accepted by the Executive Committee on behalf of the club, and arrangements have been made to insure an interesting and profitable meeting.

(Established 1832.)

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

28TH YEAR. 66TH YEAR.

PUBLISHED MONTHLY

BY

R. M. VAN ARSDALE,

MORSE BUILDING.......................................NEW YORK

G. M. BASFORD, Editor.

SEPTEMBER, 1897.

Subscription.—*$2.00 a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union.*

Subscriptions for this paper will be received and copies kept for sale by the Post Office News Co., 217 Dearborn Street, Chicago, Ill.

EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Special Notice.—*As the* AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL *is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 25th day of each month.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* **When a subscriber changes his address** *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

The paper may be obtained and subscriptions for it sent to the following agencies: **Chicago,** *Post Office News Co., 217 Dearborn Street.* **London, Eng.,** *Sampson Low, Marston & Co., Limited St. Dunstan's House, Fetter Lane, E. C.*

It is with pleasure that we announce elsewhere in this issue that the Railway Signaling Club will hold its next meeting in New York City. Since the meetings have hitherto been held in Chicago, it was impossible for more than a few of the members to take part in the discussions, and to give the Eastern members an opportunity to obtain direct benefits from the organization is an important step which will tend to make the club more truly a national affair. This movement of the signal engineers to form an association has been a modest one. It deserves success, and it is to be hoped that it will receive encouragement and support from managing officials.

In another column the counterbalance tests of the balanced compound locomotive are very briefly described. The complete report of the tests has just been received from Mr. Geo. S. Morison, too late for a satisfactory examination of the data and the conclusions drawn from them to admit of an intelligent criticism. The tests showed conclusively that the counterbalancing is in every respect satisfactory. It is, in fact, a perfectly balanced engine, and the efficiency trials brought out a number of highly interesting points concerning the engine and boilers. The latter gave good evaporative performance, remarkable steam capacity and a high ratio of water evaporated to coal burned. The engine did not do as well as the boiler, but no guesses will be offered at this time as to the reasons. The results and their import will be discussed next month.

There has been much controversy as to the best methods of applying electric traction to the movement of trains, and for several years the use of motor cars and trailers has had the approval of practice. Mr. Frank J. Sprague, whose experience in electrical engineering renders his views worthy of special attention, has developed a system of multiple unit control, which is now ready for application upon the South Side Elevated Railroad of Chicago, as is noted elsewhere in this issue. By this system each car has its own motors, and the controlling devices are so arranged as to permit of operating all of the motors from the platform of any car in the train. It is evident this will necessitate the use of small motors and rather complicated controlling devices, but the tractive weight will be distributed in a manner almost ideal. There is an advantage to be had from the better efficiency of larger motors, but the benefit to be derived from having each car independently supplied with power will be likely to outweigh the losses from the subdivision of the power. The application of this system is likely to cause much discussion, and it is well that the experiment is to be tried on a scale large enough to present positive data, from which to judge of its merits. Its best recommendation is what may be called its elasticity, and if any serious practical difficulties should appear, it is possible that they may be overcome.

The argument presented elsewhere in this issue for better inspection and maintenance of automatic crossing signals brings up a point of great importance to American railroads. The automatic signal, whether used for giving warning to the public or of maintaining space intervals between trains, has the best of reasons for its existence, and there are special reasons why the employment of automatic apparatus for these purposes should be considered good practice. We will not discuss these at this time, but will emphasize Mr. Spicer's contention for more intelligent and appropriate care. Automatic signals do not sleep, get drunk or neglect their duty, and in these respects they give better and more reliable service than men do. They require considerable attention because of the many influences which, if allowed to work long enough, will throw them out of adjustment, but when such attention is given they are found to be satisfactory in operation and are cheaper than manual signals where for the operation of the latter special men must be provided. Some day undoubtedly this matter of the necessity of looking after automatic signals will be appreciated. It is true that this is not the case to-day on a large number of roads, and signal engineers should see to it that the importance of this branch of their work is not lost sight of, for it is better to have no signal at all than to have a poor one, the operation of which is doubtful.

A prominent engineer, who has a world wide reputation as a designer of high-grade pumping engines, points out a glaring inconsistency with regard to the class of work upon which he is engaged. He wonders why the greatest possible care should be given to the design and construction of a pumping engine and its boiler plant, no expense being spared to reduce the wastes of operation to the lowest terms, and then, boiler feed pumps, that use nearly as much steam as the main engines, should be selected to do only a small fraction of the work. The usual form of boiler feed pump is proverbially wasteful in its consumption of steam, and, to be consistent, a high-grade pump should be employed for this purpose. This general criticism is not to be confined to pumping equipment. It may be asked whether marine practice is what it should be as to auxiliaries. For instance, a battleship built last year has a total horse-power of 12,280 in its main engines and in 146 auxiliary engines 2,800 additional horse-power is provided. The main engines run with an expenditure of 1.82 pounds coal of per horse-power per hour. What the consumption of coal in the auxiliary engines, constituting 22 per cent. of the power of the propelling engines would be, is an interesting question and one which is worthy of attention. Recent reports on the working of compressed air in one of our warships are interesting and suggestive in this connection.

COMPRESSED-AIR LOCOMOTIVES.

Elsewhere in this issue under the caption "Compressed-Air Traction," some figures are presented giving the mileage of the two street cars which are fitted with Hardie motors and are now running on the 125th street line in New York City, and in the May issue of the current volume will be found a statement of the cost of operating them. In our issue of March of the current volume will be found an illustrated description of the compressed-air locomotive, which has for some time been awaiting its trial upon the New York elevated railroads. It has been tried and found capable of doing the required work. Trials of compressed-air motors have not always been attended with satisfactory results, but our readers will be interested to know that the motors mentioned and also the compressed-air locomotive have given such good results as to warrant the statement that as far as furnishing the power is concerned they meet all requirements. The only question remaining to be decided is that of cost of operation as compared with other systems for similar work, and the flexibility of compressed air as applied to long-distance lines. This type of motor is somewhat handicapped as compared with electricity by the necessity for charging the reservoirs. But as this can be done with the high pressures used in the Hardie system without greater loss of time than is now experienced in filling locomotive tanks with water, no trouble is anticipated from this source. The question of cost can only be settled by experience and that already gained with the street car motors must be considered promising.

Some of the sources of loss in electric traction systems are noted elsewhere in this issue and while the efficiency of compressed air from the compressor to the locomotive cylinders is not by any means 100 per cent. it is doubtful whether the losses are more than those of electrical plants. The absence of refined experiments in this connection makes it impossible to state at present what the efficiency is, but it is not believed by the writer to be below that of electric installation as now used in every-day service.

A compressed-air system equipped with a liberal amount of storage capacity for the air compressed to the charging pressure enjoys an important theoretical advantage over an electric plant in that the engines may be adapted to a certain steady load and may be kept running upon that load nearly all of the time and in this way considerable flucuations in the demand for the air on the locomotives may be accommodated without running the power generators at either an overload or an underload. The effect this will have upon the economy of operation cannot now be stated in figures. One thing, however, seems to be proven that the noiselessness of operation, the freedom from obnoxious gases, smoke and cinders and the ease with which the compressed air is handled together constitute strong claims to attention and if the financial side of the question is as satisfactory there is a large field for the application of compressed air to tractive purposes. The opportunity for comparing the air locomotive with steam and electric systems is at hand and the figures will be looked for with great interest.

LOCOMOTIVE IMPROVEMENT.

For the present steam is the main starting point in all general applications of power in transportation. Whatever system of distribution is used steam is now the prime mover, and because of this, improvements in the application of the steam engine are most important. Of all types of steam engines the locomotive is the most difficult to improve, because of certain well understood limitations, and in other lines of steam engineering vastly greater progress has been made in the direction of efficiency.

It is not now at all difficult to build mill engines that will produce a horse-power for the consumption of 13 pounds of water per hour, and F. W. Dean says that it is as easy to produce such an engine now as it was to build one to consume 16 pounds only a few years ago. The basis for this improvement is interesting. The causes may be stated to consist of the use of steam jackets, compounding, reheating and higher steam pressures. These are all old ideas, and they are now being combined to assist in improved efficiency. Marine practice has shown similar strides, and the locomotive seems to be slower, although it must be credited with some advances in spite of the discouraging handicaps.

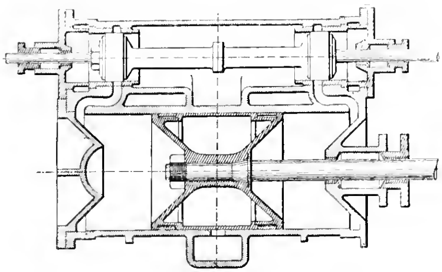
The list of subjects for the next convention of the Master Mechanics' Association includes three which may be considered as promising lines for discussion and development; they are: tonnage rating, boiler and cylinder insulation and higher steam pressures. Among the means suggested for improving locomotive performance beside those already mentioned are: Compounding, the use of lower piston speeds, larger heating surfaces, less forcing of the boilers, the heating of feed water, hot jackets for cylinders, superheating the steam and improved valve gears. Some of these must be said to be so difficult to perfect and employ, on account of complications which they involve, as to be practically beyond consideration.

The compound locomotive was stated by the President of the Master Mechanics' Association at the last convention to be still in the balance, but there were certain signs that it was gaining friends. This view is believed to be correct. The compound is gaining the confidence of engineers, and we believe justly so. More confidence will probably be placed in this type as improvements in methods of keeping fuel records are introduced. The effects of changes in the design of compounds will be better understood after the type has been studied more thoroughly upon testing plants. The chief objection to this type has been that of the additional complication involved in the design. But with recent practice the compound is very little more complicated than the simple engine, and there is even a danger of going too far in sacrificing good performance to simplicity in construction. The best marine and mill engines of to-day are far more complicated than were those of 25 years ago, but they will do more work for the same money. This applies equally well in the case of the air-brake, which is not to be considered a simple apparatus, when compared with the hand-brake. In neither of these cases is the complexity thought to be disadvantageous, and even if more cylinders and more complex valve gear are required upon locomotives in order to make them capable of doing more work for the same weight and the same expenditure of fuel the complications will eventually be considered in the same light as they are in marine and mill practice.

There are ways in which locomotives may be improved without any radical changes in design, and these are the ones which are naturally the most practical, and are to be considered as lying to one's hand. The greatest advances in the other types of engines have been in the direction of improving the action of the steam in the cylinders and reducing the wasteful interchange of heat between the steam and the metal. It is this effect that gives superheating its greatest advantage. The same applies to steam jacketing and to compounding, and to get this effect to as great an extent as possible without any of these additions is a worthy object. The jacketing of the boiler, firebox and cylinders with non-conducting coatings is one of the first improvements to suggest. No other type of steam engine is so much exposed to the cooling effects of the atmosphere as is the locomotive, and the results are easily seen in the difference between summer and winter performance sheets. Another easily applied protection against condensation losses is the separation of the steam and exhaust passages as far as possible in the cylinder and saddle castings. The steam coming through a steam pipe which is close to an exhaust passage in the same casting must be cooled and condensed to a considerable extent before it reaches the cylinder, and steam containing 5 per cent. of moisture requires five per cent. more water per horse-power per hour. It is the condensation of the steam in entering the cylinder through long passages which have been previously cooled by the exhaust steam that seems to be the most important source of loss. This is probably even more important than the condensation caused by the cylinder walls. Piston valves make it possible to use short steam passages, and this is an item of importance. Mr. L. J. Todd in a recent issue of *The Engineer* describes an interesting plan which he calls "dual exhaust," that may show itself to be adapted to reduce the effect of the cool passages, and it is

interesting in this connection, although its employment can not be advocated without further experience.

The scheme consists in using a long piston which, when nearly at the ends of its stroke, uncovers a series of exhaust ports cut through the cylinder walls and communicating with the exhaust port direct. The bulk of the steam passes out of the cylinder in this way and the exhaust closure may be regulated by means of what is called the preliminary passage, which is the ordinary valve passage. Mr. Todd makes strong claims for this system and he appears to have excellent grounds for them. He uses ordinary valve motions with piston valves and gives exhaust lap to the valve in order to delay the opening of the regular exhaust passage when running at short cut-off. In this way the card is given a larger area and the mean effective pressure for a given cut-off and boiler pressure is raised and at the same time less



steam is used per horse-power per hour. The dual exhaust ports are opened at a fixed point near the end of the stroke, and there is no trouble with choking the cylinder with steam when running fast at short cut-off. It is obvious also that the clearance spaces may be materially reduced by this plan. The piston is increased in length, and so also is the cylinder, but these are not serious objections, and the beauty of the idea is that not a single extra moving part is required. Further experiments will undoubtedly be made, and the results already attained warrant giving attention to the suggested improvement. To show the simplicity of the dual exhaust we reproduce an engraving from the article referred to.

It is believed that condensation of steam in cylinders and steam passages is not considered as being nearly as serious as it really is and it is also believed that great improvements may be made without resorting to steam or hot gas jacketing, or any other complication. The exacting requirements and the rigid limitations in the design of locomotives make it seem all the more necessary to make the most of such factors as may be easily improved and when all this is done the time will be ripe for more elaborate methods.

WHY RAILS BREAK IN TRACK.

Since the publication of the report of Mr. Thomas Andrews in *Engineering* (Feb. 26, April 16, 1897) upon the St. Neots rail, which broke into 17 pieces on the Great Northern Railway of England, there has been considerable dyspeptic discussion among engineers and editors as to the causes which produce such disasters, the general verdict being that the steel was very bad. A contemporary, in speaking of the microscopic cracks found in the worn top surface of the rail, says: "Such cracks, incipient and well developed, are, it is well known, frequently found in such a quality of high steel as well as sometimes in low steel before it has had any use whatever, and hence before any fatigue could have set in." The fact of the matter is, the rail un er consideration had been in use for 22 years and was worn out. Experience and expert opinion in this country recommend 0.60 per cent. carbon in rails of heavy section, notwithstanding the fact that Mr. Andrews says the 0.53 per cent. carbon steel rail noted is too high and would advise 0.35 to 0.42 per cent. It is also well known that sulphur has a tendency to make steel redhort, but it is not an acknowledged fact that it also makes it cold-short, although long service may possibly produce some such effect. New rails, on the contrary, are toughened to a very considerable extent by high sulphur, as is proven by accurate observation. The St. Neots rail contained 0.09 per cent. sulphur. Andrews recommends not above 0.06 per cent., while our best practice allows 0.07 per cent. At the time when our knowledge of steel was quite elementary, it was customary to lay the blame for failures upon the composition of the steel; we now know that there are other factors just as important, and even more so than composition under modern specifications.

Carbon is the element which characterizes steel. The lighter sections of rails usually contain 0.45 per cent. carbon, while the modern heavy section runs from 0.55 to 0.65 per cent. With an 80-pound rail we may expect the following tensile properties:

	Modern 0.60 per cent. C.	Common 0.45 per cent. C.
Tensile strength	125,0001-30,000	80,000-110,000
Elastic limit	55,000-65,000	35,000-45,000
Elongation (drop test)	14-18%	3-12%

We here see some points of superiority in high carbon steel which are not accounted for by composition alone. By suitable chemical composition rigid inspection, and tests following the rolling as closely as possible, the modern rail has not only gained in strength, but a remarkable increase in elongation under the drop test is shown, which is accounted for almost entirely by intelligent supervision in heating, rolling, hot-bed practice and straightening. The causes for breaking under the severe drop test of 2,000 pounds falling 20 feet are therefore principally due to an abnormal condition of the steel due to the method of manufacture, and not to composition alone.

The various constituents of rail steel and their influence upon tensile strength are quite accurately expressed by the formula of Mr. P. H. Dudley, which refers to a normal steel of about 0.55 per cent. carbon, and agrees quite closely with all steels having between 0.45 and 0.65 per cent. carbon. This formula is used as a check upon laboratory and drop tests and is not intended to apply to all steels under all conditions without certain reservations and corrections. It has been developed from actual contact with conditions of manufacture and testing, and is no doubt the most accurate yet developed. For our purpose it expresses the influence of various constituents (symbols represent per cent.) upon the tensile strength of Bessemer rail steel.

Tensile strength $= 38{,}000 + 80{,}000\ C + 25{,}000\ Mn + 20{,}000\ P + 8{,}000\ Si$.

This value must finally be corrected by certain factors derived empyrically from observation on the rails during manufacture, and it depends upon the manner of rolling, the size of rolled section, per cent. reduction from ingot to final section, upon hot-bed practice—method of cooling—and changes in mill practice with special reference to oil, gas or coal fuel, size of ingot and method of heating. Either of these may require a correction up to 10 per cent., more or less, according to degree, so that the final equation should contain also the mechanical factors as well as the chemical factors, although the investigations have not gone far enough as yet to do this for general practice, as each will require different factors. Any deviation of results from the equation will therefore represent mechanical conditions which must be looked up and corrected, as the life of rail depends directly upon these mechanical conditions.

Rails are now tested by placing a rail-butt, which would otherwise be scrap steel, upon two rigid steel supports spaced 3 feet—about two tie spaces—sometimes head up, sometimes side up, with, according to the Dudley system, equidistant punch marks on the maximum flexion fiber by which to measure the elongation. Then, in the best apparatus, a weight, falling in guides, is allowed to drop freely from a height of 20 feet upon the rail, midway between supports. A brittle rail will break—and some will withstand five such blows—but this is not the entire object of the test. What is desired with a stated composition is toughness as determined by comparative elongation, and rigidity as determined by deflection. For example: a single drop upon an 80-pound rail of 0.60 per cent. carbon caused it to deflect 2.16 inches and spring back to 1.60 inches permanent deflection, show-

ing an elastic reaction of 0.56 inches. The same weight and rail, with supports spaced 4 feet, and a drop of 13 inches, returned to its original straight condition, not having had its elastic limit exceeded, while a 20-foot drop caused a permanent set of 2.46 inches and an elastic reaction of 0.81 inch. The total elongation is taken after two drops in each instance, as one drop of 20 feet is not sufficient to reach the full limit. The final elongation agrees well with that obtained in a tensile testing machine; the use of suitable chemical composition has done much to improve this factor.

Hardness is obtained by increasing carbon or rolling while rather cool. "Hot-rolling" makes a soft steel which will warp on the hot-bed on cooling, while blue "cold-rolling" increases its surface hardness and tensile strength, but puts the rail into a bad mechanical condition which shortens its life in track by reason of severe internal stresses. A happy medium with a thin head will give the best results. The top of the rail should not be ridged or round, but should conform to the shape of the tire, as otherwise wheel pressure will cause the surface metal to flow, the hard surface skin will be worn through and the rail will not only wear rapidly, but will also deteriorate deeper into the head of the rail. Thick heads have been abandoned largely, because so much metal in the section caused the head to cool so slowly that it was practically in an annealed or softened condition when it should have been at least as hard as the rest of the rail.

Suppose a lot of rails, just received by a railroad, have been made under specifications and inspections: it is at least hoped that they are free from roll cracks in the flanges and from splinters or chisel marks of any kind. We cannot be so sure as to long hollow spaces or pipes in the rail, small flattened spaces or compressed blow holes, segregations, or incipient cracks produced by careless straightening. All these require that the inspection be more than usually thorough, and that the inspector be a specialist in the subject of steel. Let us suppose the rail to be free from these defects which would be points of weakness where breakage would probably first take place ; we would first have to look for any dents in the flange of the rail. If one is found, a tie should be placed under this point and additional spikes put in, for the rail will break at such a point long before it will at any other.

Fatigue is the gradual deterioration or breaking down of the steel due to the movement of the particles of steel among themselves. Therefore in a break due to continued stresses, the time required varies directly with the number of such stresses and inversely with their magnitude. As a line of weakness exists between any two adjacent areas in different mechanical conditions, the border line between them will be where fracture first occurs whether these areas differ through temper, annealing, compression or shear. Suppose one rail falls across another in unloading and the head of one makes a dent in the flange of the other, or suppose a trackman's maul misses a spike and dents the flange; in either case a fracture will be likely to ultimately occur at this point starting in a curve around the edge of the bruise, extending diagonally, then straight across the bottom until the flanges are broken. It will then rise into the web, run nearly horizontally for a short distance, rise in a curve to the head and break square through it. A large proportion of rail breakages occur in some such manner. It is extremely rare that a rail in normal condition breaks in ordinary service unless it is worn out, when, like the "one-hoss shay" or the St. Neots rail, it goes to pieces all at once. An average life of 15 years for most light rails now in track can be assumed with safety if the traffic is not severe and the rails are carefully made. Low prices, cheap labor, high pressure mill practice, and a determination bordering on desperation of the mill superintendent to make whatever is required, without regard to the ultimate results, have resulted in the production of a large number of inferior rails, whose life in service is not as long as it should be. This has been met by specifying heavier sections of greater rigidity, so that the unit load is much less now than formerly, and longer life can be expected.

Referring to the excellent work of Mr. P. H. Dudley (*School of Mines Quarterly*, January, 1897), we find that the old 4.5-inch rail, 16 ties per rail, with 20,000 pounds per driving wheel, had a fiber stress of 12,000 to 16,000 pounds per square inch. With 5-inch rails these figures reduce to 5,000 to 8,000 pounds, while in the 6-inch 100-pound rail the highest stress yet noted is 4,000 pounds. This under a wheelbase of 8 feet 6 inches and static loads. We see that in going from a 60-pound rail to a 100-pound rail we have reduced the working stress to one-fourth, and have a rail less subject to the effects of fatigue, and of such stiffness that the wear on rail, joints, spikes, ties and ballast is reduced to a minimum.

When rails break through the end bolt hole the fracture through the hole is at an angle of about 45 degrees either way. Various persons attribute this to as many causes. Advocates of patented joints claim that the under side of the rail head wears both itself and the angle bar at the end ; then when the wheel jumps over the joint, the rail remains rigid and the rail end bends down slightly and ultimately breaks. They therefore recommend a "base support" or reinforced plate under the joint. It sometimes happens that the bolt hole in the rail is improperly spaced and that in cold weather there is considerable tension on the rail. Every joint deflection increases this tension and finally the combination of tension and bending moment breaks off the end. Some also contend that the side blow due to lateral oscillation of cars on track or pressure on curves will tend to twist the rail and assist in its fracture. Joints which are too wide open certainly contribute largely, for a hammer blow on the rail end, far exceeding in effect an equal static load, occurs at every wheel, proportional in severity to the space jumped over. Trackmen differ as to placing the joint over a tie or between two ties. Angle-bars break from above downward, while rails break from below upward. Therefore the microscopic cracks noted by Mr. Andrews, before referred to, probably had no bearing on the subject.

Other causes for breaking of rails may be the hammer blow of the excess of counterbalance possessed by locomotive drivers, the thump of "flatted" wheels, cold weather, poorly tamped ties, an old tie between two new ones, or a tie cut into deeply by the rail where no tie-plate is used, wrecks, and other contributory causes, all of which have their influence. In general, a blow gives the more severe stress, and if such blows succeed each other at a point where some part or all of the section has had its elasticity destroyed by a bruise, a cut, a dent, a gag mark, cold bend, or similar cause, fatigue will occur and fracture follow in one or several stages.

In order that a rail shall not break in service the following conditions must be satisfied:

1. It must be of such a strength that the working stress shall not exceed one-fifth the elastic limit. 2. It must have sufficient toughness not to break with such deflections as may occur in poor track, and sufficient rigidity to distribute all shock or vibration over several ties instead of one, and thus insure smooth riding, even if the ties are poorly tamped. 3. There should be no internal stresses locally distributed in the steel due to cold rolling, unequal cooling, cold bending (as far as possible), or local heating. 4. There should be no dents, flaws or other signs of bad usage on the rail; in some roads a splice bar is placed at such a mark in anticipation of the rail breaking there. Rails must be carefully handled, especially when of small elongation and high carbon. 5. Eternal vigilance in track inspection, supplemented occasionally by some such record as is given by a dynagraph car, or similar device, is necessary; and above all, the realization that brains in manufacture, inspection and maintenance are worth as much as brains in anything else.

TEN WHEEL VS. MOGUL LOCOMOTIVES.

For a good many years a favorite topic for discussion at technical meetings of railroad men has been the relative merits of mogul and 10-wheel engines. It has been generally claimed that the mogul engine permits of an ideal distribution of weights, all of the weight of the engine being available for tractive purposes except the 15,000 to 20,000 lbs. carried on the two-wheel truck, while in the 10-wheel engine a larger percentage of the

total weight must be carried upon the truck. In favor of the 10-wheel engine it has been urged that the four-wheel leading truck is a safer and simpler construction and gives less trouble from the cutting of truck-wheel and driving-wheel flanges. Whatever may have been the force of these arguments in the past, it appears now as if the choice between the two types is to be decided upon an entirely different basis and in favor of the 10-wheel engine. The tendency of modern locomotive design is toward very large boilers and rightly so, and assuming that the conditions of the service necessitate three pairs of drivers, it generally happens that when a boiler large enough for modern requirements is provided the total weight of the engine becomes greater than is desirable to carry upon three pairs of drivers and one pair of truck wheels. This is the case even when liberal weights per axle are permitted. Furthermore, modern practice in several details has a tendency to move forward the center of gravity of the engine and place more weight on the leading truck. Thus the great strength needed in cylinders and cylinder saddles on account of the high steam pressures carried necessitates the use of heavy walls and flanges throughout these castings. The fastenings between the two half saddles and between the saddle and the boiler are now of greatly increased strength and have involved a large increase of weight at this point. The better fastenings of the cylinders to the frames also add considerable weight, and the frames themselves are made much heavier in front of the front jaw than in the past. Add to this the heavier smokebox rings and liners in the smokebox, and we have altogether a large accession to the weight which must be carried on the truck. Furthermore, the use of radial stays instead of crown-bars reduces the weight at the back end of the boiler, thereby causing a transfer of weight from the drivers to the truck. The result of these changes in details is to make the weight on the forward equalizing system of a mogul engine greater than can be conveniently carried there, for if the weight on the two-wheel truck is kept within reasonable limits the weight on the front pair of drivers becomes greater than that upon either the main or rear pair of wheels. True, this difficulty can in part be overcome by a long "overhang" of the boiler back of the rear drivers, but the limit in this direction is soon reached, particularly if it is not considered desirable to have the boiler extend into the cab further than in the common eight-wheeled engine. Thus it appears quite clear that in designing an engine for heavy service in which three pairs of drivers will be needed to carry the tractive weight desired, the 10-wheel engine is much to be preferred to the mogul engine, because of the greater total weight of engine that can be obtained within a given limit of axle loads, and because the four-wheel truck is needed to carry the greater weight now placed on the leading truck by recent changes in details of locomotive construction and because of the greater elasticity or general adaptability of the design.

NOTES.

The letter ballot upon the standards and recommended practice of the Master Car Builders' Association, which closed Aug. 2, resulted in the adoption of all the questions submitted. Two standards and six recommended practices are thereby added to the association's list.

Sanding the ends of postal and other cars which are run next locomotive is shown by Mr. A. J. Bishop, writing in the *Railroad Car Journal*, to be a very satisfactory practice. He describes a portable sand blast apparatus for applying the sand and shows that the work may be done for 24 cents per coat per car end for paint and sand.

Under the caption American Rails for India the *Mechanical World* discusses the recent underbidding of English railmakers for the business of the Indian railroads by £1 per ton on a total of £8,000 on a single order and preaches the doctrine of protection to home industries. This is a high tribute to American railmakers and their method of securing low cost of production.

A year or so ago the Lehigh Valley road proposed to its shop employees to make for them and their families the low passenger rate of half a cent a mile in lieu of passes, and to devote the entire receipts to a fund for the employees' benefit. According to the *Railway Age* about $15,000 has already been realized by this co-operative plan and 15 superannuated workmen now receive regular incomes therefrom.

The Atchison, Topeka & Santa Fe is putting up block signals on 73 miles of its main line in Kansas and on 100 miles of the Emporia branch. Apparatus and electrical connections will be used similar to those on the Chicago, Milwaukee & St. Paul Railway. Several new telegraph offices will be established. The Atchison has 14 miles of automatic electric block signals between Kansas City and Holliday.

The latest development in the direction of transportation equipment is the Behr Monorail Electric Railway, of which a sample is now in operation in connection with the Brussels Exhibition. It embodies a car of peculiar shape, a great deal of machinery, a single rail structure of V section and more strange ideas than are ordinarily found even in 150 mile per hour, electric, air line railroad schemes.

Conditions of railroad operation must be changing much more rapidly in this country than in England. We are told by an English engineer that on the Great Northern Railway a type of locomotive designed 28 years ago has been perpetuated and repeated with success ever since with scarcely any change even of details. We wonder how an American eight-wheeler of 28 years ago would feel in tackling the Empire State Express of to-day.

The beauty of the electrical illumination of the British warships at the recent review at Spithead must have been striking. *The Engineer* informs us that the total illuminating power of the fleet was about 739 320 candles, and that 3,850 horse-power was required to drive the dynamos. An idea of the number of lamps is given by the statement that when put in a single line and 5 feet 6 inches apart they would reach about 54 miles. This will undoubtedly be charged to development of patriotic pride in the navy—a worthy object.

The latest Niagara power scheme is the utilization of the power of the falls through impulse wheels, and Mr. F. M. F. Cazin proposes to get a head of nearly 200 feet by means of a flume and penstock constructed through the solid rock. The pressure wheel will undoubtedly do the work more efficiently than the slow-speed turbine in present use at the falls, and the former would give the additional advantage of higher generator speeds. These wheels would permit of saving much of the present waste of head at the plant of the Cataract Construction Company.

The steps just taken by the Navy Department to secure an additional supply of rapid-fire guns puts beyond question its ability to arm seasonably the vessels of the merchant marine now counted upon as auxiliary cruisers. There are 19 such vessels on the Atlantic coast and nine on the Pacific, the former including the large passenger steamers *New York*, *Paris*, *St. Louis* and *St. Paul*. The current contract arrangements include six 6-inch guns, twenty-five 5-inch and fifteen 4-inch.

Railway speeds in England for this year have not increased, but to the great sadness of Mr. Chas. Rous Martin, writing in *The Engineer*, have decreased with respect to the traffic to the North, and the glory of running the fastest regular trains remains to the United States. The record for long continuous runs is held by the Great Western Railway, with a regular train from London to Exeter, 194 miles, without a stop. The London & North Western continues to run four regular trains daily from Euston to Crewe, 158 miles, without stopping.

One of the interesting features of the Shoreditch (England) electric installation is the use of accumulators. The battery is capable of discharging at a rate of 171 amperes for six hours at least, and of maintaining a minimum electromotive force of 165 volts throughout the discharge. It is also capable of being discharged at a much higher rate, the maximum being 350 amperes.

The capacity of the battery for a higher discharge rate than the normal being 272 amperes for three hours, the minimum electromotive force of 165 volts being maintained in all cases.

The electric capstans used for switching cars on the Northern Railroad of France are described in the *Revue Generale des Chemins de Fer*. A capstan is placed in an angle between the tracks, where a rope can be easily led either to the turntables or the cars on the adjacent tracks. The motor is horizontal, the armature shaft being geared directly to the spindle of the capstan. The capstan machinery is very carefully protected from water, and no trouble has been experienced in this direction. The rheostats and other controlling devices are placed in the cavity containing the motor.

The M. C. B. axle to carry 31,000 pounds is discussed editorially in a recent issue of the *Railway Master Mechanic*, and while the design is approved as far as the engineering of it is concerned, it is suggested that the journal might have been made 8 inches long instead of 9 inches. The shorter journal would offer the advantage of permitting the axle to be used in other journal boxes and with lighter loads when it had worn down too small for a load of 31,000 pounds. The conclusion reached is that the 9-inch journal will not be used by roads handling cars of various different capacities.

The new Sprague system of electric traction, which is to be applied to the cars of the South Side Elevated of Chicago, was tried on the experimental track of the General Electric Company at Schenectady July 26. The train of six cars was controlled by the multiple unit system from the forward car. Each car has two 50 horse-power motors and the whole train may be handled from the platform of any car, either during switching or after the train is made up. The current is supplied to each car separately and perfect independence of the cars is thus secured. The trial was a success both as to speed and control.

Ground was broken in New York City, Aug. 2, for the pneumatic mail tube system, which is expected to be in operation on Oct. 1. The first tubes will consist of two double lines of 8-inch tubes, one between the Produce Exchange and the Post-Office, by way of South William, William and Beekman streets, the other extending from the Post-Office to the substation at Forty-fourth street and Lexington avenue, and connecting with substations along the route. Another system of tubes, to be constructed later, will extend from the General Post-Office to the Brooklyn Post-Office by way of the bridge and under Washington street, Brooklyn.

The many friends of Lehigh University will be glad to know that the financial relief which is provided by the State will enable the institution to pursue the work in which it has so long been engaged. The temporary embarrassment was occasioned by the failure of holdings of railroad stock to pay their usual interest, and the sum of $150,000 which the State has furnished is timely. The plans for future development of the University are not to be curtailed, and it is likely to become stronger than ever among the institutions of its class. There was no foundation for reports that its doors were likely to be closed, but undoubtedly the work would have been seriously curtailed had the State not made this liberal grant.

Three notable cases of broken propeller shafts on ocean steamships have occurred within a short time. The shaft of the North German Lloyd ship *Spree* broke on the voyage leaving New York June 28, and the shaft of the *Cephalonia* is reported to have been so badly sprung on the morning of July 4 as to disable the ship. The third case occurred upon the Hamburg-American liner *Normannia*, and was discovered on the morning of July 29, just as the ship was to leave the dock at Hoboken, N. J. In this case the break extended about two-thirds through the shaft, and it was fortunately discovered before the ship had put to sea. These three cases occurring so close together draw attention to the subject of the effect of repeated stresses and the vibrations of the shafts, or of the ships on a whole, as one which is worthy of study.

The comparative cost of maintenance of M. C. B. and link and pin couplers is stated by Mr. R. M. Galbraith, General Master Mechanic of the St. Louis Southwestern Railway, writing in the *Railroad Car Journal*, to be $389.37 for 63.2 per cent. of the cars which were equipped with the link and pin, as against $73.23 for the maintenance of M. C. B. couplers upon 36.8 per cent. of the cars. He also shows that 85 per cent. of the break-in-twos of trains were caused by links of link and pin couplers breaking, or by the breakage on jumping of the pins. These figures are taken to show that the M. C. B. coupler is here to stay, as this writer puts it. The information is interesting in view of the fact that many blame the new coupler for troubles that are considered worse than those which were experienced before it was introduced.

An ingenious device for automatically regulating the feed pumps of boilers of the water-tube type has been worked out and applied by Messrs. Yarrow & Company. It consists of placing the steam pipe that supplies the pump with its opening in the boiler at such a level that it will be covered by water when the water in the boiler has reached the proper height. The pump is worked by steam when the water is below that level and by water when above it. The pump runs very slowly when driven by water, and when the engines are shut down the pump throttle is presumably closed. The pump makes about 45 strokes per minute when driven by steam and about six strokes per minute when driven by water. An attachment whereby the end of the admission pipe may be easily raised or lowered completes the arrangement, which is said to operate with perfect satisfaction.

The humiliation caused by the necessity of sending the battleship *Indiana* to Halifax to be docked for cleaning and painting has brought about the appointment of a board of inquiry to report to Congress upon the needs of the navy in this respect on the Atlantic coast. The cost of docking at Halifax is an item of importance from the fact that the charge in this case is said to be $800 per day for the four days. The Halifax dry dock is the property of a company. It cost $1,000,000 to build, and it is on a good financial basis on account of the subsidies it receives from the British government, the Dominion government and the city of Halifax, each of which contributes to it $10,000 annually. It is on account of the Imperial and Dominion subsidies that the British Admiralty have a prior right to its use whenever they require it. The dock is 600 feet in length and the *Indiana* 348 feet long.

We recently chronicled the high speed of the compound steam turbine vessel, the *Turbinia*, at 32¾ knots per hour, and during the month of July the same boat, which it will be remembered is only 100 feet long, made a record of 35 knots, or 40 miles per hour. At this speed, Mr. Parsons says, the engines indicated 2,400 horse-power, with an expenditure of 14 pounds of steam per indicated horse-power per hour. These results warrant looking to the steam turbine for important improvements in marine propulsion in spite of certain disadvantages possessed by these engines. The chief difficulty at present is that they will not reverse, but this is not believed to be insuperable. Trials with larger vessels at lower rotative speeds of from 250 to 500 revolutions per minute may be looked for in the near future, and Mr. Parsons says that for large ships the turbines would be even more simple than those in the *Turbinia*.

The Liverpool Overhead Railway uses gearless motors and of these Mr. S. B. Cottrell, Engineer and General Manager, says: "I consider that the gearless motor is better for our work than a single reduction motor. The cost of repairs to motors is trifling compared to what the cost of repairs of locomotives would be to work a similar service. To effect repairs the wheels and axles are taken out of the truck frames and there is no difficulty in repairing the armatures on the axles. I do not see that there is any more trouble with the failure of armatures with gearless motors than there would be with geared motors. I do not think that either gearless or geared motors make any difference to the track joints, as the blow in either case must be the same." As to the location of the third rail he says: "The conducting rail should be, wherever practical, put in the center, as we have done here.

for we find no difficulty with it even at complicated crossings, whereas placing at the side and higher than the running rail, would offer many complications at cross-over roads."

Mr. M. H. Gerry, Jr., in a paper recently read before the American Institute of Electrical Engineers, gave some interesting data concerning the wastes occurring in the use of electricity upon the Metropolitan Elevated in Chicago. The loss by heating the motors on one of the cars which are capable of exerting a drawbar pull of 4,000 pounds, working under ordinary conditions, with an atmospheric temperature of 60 degrees Fahr. is about 15 horse-power. Starting at the engine shaft the losses are as follows: The generator will return about 90 per cent. of the work put into the armature shaft; of the amount furnished by the generator, from 10 to 25 per cent., and may be more, is lost in transmitting the current from the generator to the controller on the car; the losses in motor and car apparatus are such that 50 per cent. of the power supplied by the generators is lost between the generators and the car axle. This may be stated as follows: If 51 horse-power is required to propel the train there must be 108 horse-power provided at the engine shaft.

In speaking of the selection of tools for workshops an English contemporary, *The Practical Engineer*, clearly expresses the importance of capacity and simplicity of tools which are to be given hard usage. The author admits that it seems a pity to sacrifice old tools which are capable of doing much work. There is some sacrifice in doing away with them, but the change is not all sacrifice. Compare the lathe which used to do duty as a general tool, which may be employed to turn a bolt or stud, or bore a hole just as required, with the capstan head machine, with its six or eight special tools, the hollow mandrel and its gripping jaw, with which a boy can turn out special bolts or studs, without any alterations that involve much trouble, no time being wasted in centering or looking for carriers, etc., and one can easily estimate the value of the gain that such a tool is in a workshop. A technical education we need is the power to discriminate between the cheap and well-designed tools offered by the best makers and the lower-priced but very costly devices offered, like patent medicines, as being capable of doing anything required and result in being a source of annoyance to all concerned.

Compressed air is one of the most flexible of power transmitters and to this attribute it owes much of its success. Mr. A. Kirk, in a recent discussion before the Engineers' Society of Western Pennsylvania, in speaking of the transmission of air-pressure through a considerable distance said: "We were working in a stone quarry on a large drill, I think it was 3½ diameter. The quarry was started within 100 feet of the compressor. We worked there for some time, but a change in the strata of rock showed the rock contained too much silica for furnace purposes, and we had to go nearly a mile and a half away from the compressor and begin operations again. We were contemplating, and even made arrangements, to move the compressor nearer to the new quarry, but the compressor was in a very convenient locality, near other machinery, and if it could remain where it was it would save the expense of an independent engineer, and save the trouble of carrying coal and water. I finally insisted that it should remain where it was, stating that we could pipe the power to where we wanted it. This was done, and we found that we could use the compressed air through a 1½-inch pipe to as much advantage a mile and a half away from the compressor as we could within 100 feet of it.

Personals.

Mr. George W. Turner, formerly Superintendent of Motive Power of the St. Paul & Pacific, died at St. Paul July 7, aged 66 years.

Mr. F. P. Boatman has been appointed Master Mechanic of the Columbus, Sandusky & Hocking, with headquarters at Columbus, O.

Mr. Nat C. Dean has been appointed Western Representative of the Fox Pressed Steel Company, with office 1413 Fisher Building, Chicago.

Mr. David Anderson has been appointed Master Mechanic of the Northern Ohio, with headquarters at Delphos, O., to succeed Mr. J. T. Clark.

Mr. A. L. Whipple, Manager of the railroad department of the Boston Woven Hose and Rubber Company, has removed his headquarters to 205 Lake street, Chicago.

Mr. S. King has been appointed Master Car Builder of the middle and northern divisions of the Grand Trunk, and will be in charge of the car shops at London, Ont.

Mr. F. H. Coolidge has been appointed Western representative of the Lappin Brakeshoe Company and the Gold Car Heating Company, jointly, at Chicago.

Mr. Daniel S. Lamont, who was Secretary of War under President Cleveland's administration, has been elected Vice-President and Director of the Northern Pacific Railway.

Mr. Jesse Fry has been appointed General Manager of the San Antonio & Gulf Shore, with headquarters at San Antonio, Tex., in place of Mr. George Dullnig, resigned.

Mr. David T. Bound has been appointed General Superintendent and Purchasing Agent of the Wilkes-Barre & Northern at Wilkes-Barre, Pa., to succeed Mr. A. A. Holbrook, resigned.

Mr. C. A. De Haven has been appointed Master Mechanic of the Kansas Midland Railway, and will have charge of all matters pertaining to the locomotive and car departments, with headquarters at Wichita, Kan.

Mr. R. D. Wade, who was for many years Superintendent of Motive Power of the Richmond & Danville, afterward absorbed by the Southern Railway, has accepted a position with the Baldwin Locomotive Works.

Mr. R. H. Soule, who recently resigned the position of Superintendent of Motive Power on the Norfolk & Western Railway, has accepted an appointment with the Baldwin Locomotive Works, beginning Aug. 1.

Mr. George S. McKee, Master Mechanic of the St. Louis division of the Cleveland, Cincinnati, Chicago & St. Louis, at Mattoon, Ill., has been appointed Master Mechanic of the Wabash, with headquarters at Moberly, Mo., to succeed Mr. Thomas E. Butterly, resigned.

On account of ill health, Mr. E. M. Humstone, Assistant Superintendent and Master Mechanic of the Philadelphia, Reading & New England, has been granted a leave of absence, commencing Aug. 1. Until further notice Mr. H. Schaefer will act as Master Mechanic.

Mr. Emil Gerber has been appointed Chief Engineer of the Lassig Bridge and Iron Works, Chicago. Mr. Gerber and the bridge company are to be congratulated on the appointment. We have received the notice too late to say more about Mr. Gerber's work than that he has for a number of years been associated with Mr. George S. Morison.

Mr. L. E. Johnson, Superintendent of the Michigan Division of the Lake Shore & Michigan Southern, has been appointed General Superintendent of the Norfolk & Western, with headquarters at Roanoke, Va. He was born in Aurora, Ill., in 1846, and began railroad work in the shops of the Chicago, Burlington & Quincy. He passed successively through the positions of fireman, engineer master mechanic and division superintendent on that road. In 1888 he left the Chicago, Burlington & Quincy to accept a position as Superintendent of the Montana Central. He remained there till 1893, when he accepted a division of the Lake Shore & Michigan Southern.

Mr. S. R. Callaway, President of the New York, Chicago & St. Louis, was on Aug. 18 chosen President of the Lake Shore & Michigan Southern, with headquarters at Cleveland, O., to succeed the late D. W. Caldwell. Mr. Callaway succeeded Mr. Caldwell as President of the N. Y. C. & St. L. in January, 1895, and previous to that date was for over four years President of the Toledo, St. Louis & Kansas City. He was Second Vice-President and

General Manager of the Union Pacific system from September, 1884, to June 30, 1887, and from 1881 to 1884 was General Manager of the Chicago & Grand Trunk, and President of Chicago & Western Indiana and Belt Railway of Chicago.

Mr. Edmund S. Bowen, who has had a long and successful railroad career, died Aug. 19, in New York City. He was born in 1831 at Martinsburg, Pa., and entered railroad service at the age of twenty; since that time he has held the following positions: Rodman engineer corps of the Pennsylvania Railroad, Assistant Engineer of the same road, Assistant Engineer of the Sunbury & Erie, Resident Engineer of Northern Central, Division Superintendent of the same road, General Superintendent and Chief Engineer of the Kansas Pacific, General Superintendent of the New York, Lake Erie & Western, and Vice-President of the same road, from which position he retired in October, 1885, on account of ill health. In September, 1888, he was made General Manager of the Rome, Watertown & Ogdensburg, and 1892 he was made Assistant to the President of the New York & New England road.

Mr. Henry S. Marcy, President of the Fitchburg railroad, died suddenly trom a stroke of apoplexy, at his home in Belmont, Mass., Aug. 10, at the age of 60 years. He was born at Hartland, Vt., Jan. 28, 1837, and entered railway service April 1, 1858, as Master of Transportation of the Sullivan railroad. After holding that position for 3½ years he went to the Rutland & Bennington, Oct. 1, 1861, as clerk to the superintendent, and in May, 1863, was made Master of Transportation. He was Acting Superintendent of the same road from July, 1864, to November, 1865, and was then until May, 1871, General Freight Agent of the Rensselaer & Saratoga. He was appointed General Freight Agent of the Delaware & Hudson Canal Company in May, 1871, and held that position for 14 years. He was then Traffic Manager of the same company until Nov. 1, 1889, when he was chosen President of the Fitchburg Railroad.

Mr. C. S. Mellen, Second Vice-President of the New York, New Haven & Hartford, was chosen President of the Northern Pacific at a meeting of the board in New York Aug. 12, to succeed Mr. E. W. Winter, whose resignation was accepted, to take effect Aug. 31. The new president is 46 years of age and has been in railway service since 1869. His first railroad work was with the Northern New Hampshire, where he began as a clerk in the cashier's office. He remained with that road in various minor positions until 1880, with the exception of one year's service with the Central Vermont, and on Oct. 1, 1880, was appointed Assistant to the Manager of the Boston & Lowell. He was successively Auditor, Superintendent and General Superintendent of that road until June 1, 1888, when he accepted the position of General Purchasing Agent of the Union Pacific. The following November he was made Assistant General Manager of the Union Pacific, and on March 1, 1889, was appointed General Traffic Manager of that system. He resigned the latter position April 1, 1892, to accept the position of General Manager of the New York & New England, and was chosen Second Vice-President of the New York, New Haven & Hartford, Oct. 27, 1892.

Books Received.

La Machine Compound. Conférence par A. Mallet, Ingénieur Civil. Extract du Bulletin de la Société Industrielle de L'Est. Nancy, 1897.

Reconstructed American Monitors. By Passed Assistant Engineer F. M. Bennett, U. S. Navy. Reprinted from Journal of the American Society of Naval Engineers.

Eleventh Annual Report of the Commissioner of Labor, 1895-1896. Work and Wages of Men, Women and Children. Government Printing Office, Washington, D. C., 1897.

Twenty-Eighth Annual Report of the Board of Railroad Commissioners of the State of Massachusetts, January, 1897. Public Document, No. 14.

Modern Freight Car Estimating, Containing Necessary Information and Tables Appertaining to the Proper Method of Compiling Correct Estimates on Freight Equipment. For Car Manufacturers and Railroad Officials. Edited by O. M. Stimson. Anniston, Alabama, 1897, 500 pages, illustrated, folding tables, standard size (6 by 9 inches), flexible morocco, gilt. Price, $5.00.

Transactions of the American Institute of Mining Engineers, Vol. XXVI., February, 1896, to October, 1896, inclusive. New York. Published by the Institute, 1897.

Michigan Engineers' Annual, Published by the Michigan Engineering Society, 1897.

State Supervision of Grade Crossings of Steam and Electric Railroads. By Charles Hansel, M. Am. Soc. C. E.

Proceedings of the Fourth Annual Convention of the Association of Railroad Air Brake Men Held at Nashville, Tennessee, April 1897.

Armour Institute of Technology Annual Year Book for 1896-1897, with announcements for 1897-1898.

The Official Railway List, 1897. A Directory of Presidents, Vice Presidents, General Managers, etc., and a Hand-Book of Useful Information for Railway Men. Sixteenth year. Chicago: The Railway List Company, 1897. Price, cloth, $2; flexible leather, $3.

The Engineer's Sketch Book of Mechanical Movements, Devices, Appliances, Contrivances and Details. By Thomas Barber, Engineer. Third Edition, 2603 illustrations. London, E. & F. N. Spon. New York, Spon & Chamberlain, 1897. Price, $4.

The Stone Industry in 1896. By William C. Day. Department of the Interior, U. S. Geological Survey. Charles D. Walcott, Director. Washington, Government Printing Office, 1897.

Herzogliche Technische Hochschule Curolo Wilhelmina zu Braunschweig. Programme for the years 1897-1898. Braunschweig, 1897.

Light Railways. Practical Hints for Light Railways at Home and Abroad. By F. R. Johnson, Late Executive Engineer Assam-Bengal Railway, Mem. Am. Soc. C. E. London, E. & F. N. Spon New York, Spon & Chamberlain, 12 Cortlandt street. Price, $1.

Maximum Stresses in Framed Bridges. By William Cain Member A. S. C. E., Professor of Mathematics in the University of North Carolina. New York, The Van Nostrand Science Series, No. 38. New York, D. Van Nostrand Company, 1897. Price, 50 cents.

New Publications.

Modern Freight Car Estimating. Containing necessary information and tables appertaining to the proper method of compiling correct estimates on freight equipment. Edited by O. M. Stimson. Anniston, Ala.: Stimson & Company, 1897. Octavo, 510 pages, with index, engravings and folding tables; flexible morocco, gilt. Price, $5.

This book was written for the use of railroad car department officers, freight car builders, estimators and others who have to do with the details of car construction or repairing, and is the result of the thought given to this subject during 16 years of experience which the author had in various departments concerned with car works, five years of which were spent with the Pullman Company. It is a very elaborate work, bearing upon the proper method of making correct and intelligent estimates upon railway freight equipment. But the object of the author was to accumulate and reduce to concise form the very large amount of information necessary to compile a complete estimate, and further to afford accurate references to comparisons of the difference in cost between the various appliances entering into freight car construction. The introductory chapter, under the head of compiling of estimates, treats at considerable length of the duties of the various department heads in car manufacturing and railroad shops. This is followed by chapters dealing with the various appliances such as trucks, bodies, draw gears, bolsters, brakes, roofs and doors. Under each of these divisions is subdivided the large number of different devices each beginning with the Master Car Builders' standard or recommended practice, and upon which as far as possible all are based. These are accompanied by drawings. Complete bills of materials in the minutest detail are given, followed by summaries, thus enabling the purchaser with very little work to price the quantities in his own territory, thereby enabling him to have accurate and detailed comparisons of the difference in cost between the application of one device and another. An appendix gives carefully selected weights and measures commonly used in car estimating, and the complete specifications of all material entering into freight car construction as required by the Pennsylvania Railroad are reproduced in a second part. Another appendix contains blank forms for complete bills of material. The book is well printed and well bound.

Some of the illustrations are reduced to too small a scale, but aside from that we commend it strongly in every respect, and believe that all car department officers and car builders who have to do with estimating will be glad to have it. The preparation of the work was thorough and much information is given in connection with the chapters on trucks, car doors, draft gears and bolsters.

THE MATERIALS OF CONSTRUCTION: A TREATISE FOR ENGINEERS ON THE STRENGTH OF ENGINEERING MATERIALS. By J. B. Johnson, C. E., Professor of Civil Engineering in Washington University, St. Louis, Mo. First edition. New York: John Wiley & Sons. London: Chapman & Hall, Limited, 1897. Price, $6.

This book is one of the most valuable of recent additions to engineering literature, and it would be difficult to give too much praise to the author and the publishers for rendering the contents available at this time. There has been a great deal of good material in the line of reports of tests scattered through technical literature, but it has never before been collected, digested and presented in available form for easy access and consultation. The work which has been done in this and foreign countries has been grouped and analyzed by Professor Johnson, particular attention having been given to research which has taken the direction of the establishment of fixed laws. Engineers will appreciate the book which places at their disposal the cream of the valuable records of the United States Arsenal tests conducted at Watertown, Mass., which now fill fourteen large volumes. The work done by Bauchinger, Tetmajer and Martens has also been called upon to furnish an important part in the book. The investigation of cements, mortars and concretes made during the construction of the St. Mary's River canal locks, Kirkaldy's reports and the original investigations of the author for the U. S. Forestry Division have all contributed to the book, and wherever possible the results have been shown graphically, which is one of the features of the work. The usual method of recording tests is to put them in the form of tables, and the diagrams are certainly much more convenient for consultation by busy men. This plan exhibits at a glance the relationships of the data. The subject of timber tests is very fully treated. Prior to the tests by the Forestry Division of the U. S. Department of Agriculture comparatively little was known about timber, and the author's intimacy with these tests enables him to bring out the conclusions with effect. No attempt is made to establish rules for guidance in designing or to propose original specifications to be used in the purchase of materials, but the book is the result of an effort to impart knowledge of the properties of materials, showing upon which these depend, the causes of variation and defects and instruction in means for discovering these, all with a view of preparing a reader to draw his own specifications and establish his own rules. The author rather boldly proposes the following definition: "The apparent elastic limit is the point on the stress diagram of any material, in any kind of test, at which the rate of deformation is 50 per cent. greater than it is at the origin." This, the author says, should not be made to apply to materials not perfectly elastic within any limits. He proposes to extend the meaning of the term so as to make it applicable to all elastic materials, and at the same time to make it serve as the "elastic limit" to be universally used in all kinds of practical tests. Space is not available for more than a statement of this definition and the author bespeaks careful consideration of his stress diagrams before his views are condemned. The fact is that the term "elastic limit" is a most indefinite one, and unless it is defined whenever used it means nothing. This is a most important subject and Professor Johnson's wide experience should count in estimating the value of his arbitrary method of fixing the apparent elastic limit. The sources of information given in the text and legends accompanying the engravings are acknowledged. Among the illustrations are many taken from photographs of specimens after fracture or special treatment. The book is divided into four parts. Part I. is devoted to the crushing strength of brittle materials. Part II. presents the methods of manufacture of cast iron, wrought iron, steel, alloys, cement and brick. In this part 100 pages are given to timber and timber trees, the matter never having been brought together before in such a work. Part III. describes testing machines and methods of testing, and part IV. covers the mechanical properties of materials of construction as determined by actual tests.

PROCEEDINGS AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION. Thirtieth annual convention, held at Old Point Comfort, Virginia, June, 1897.

The promptness of the appearance of this report, which must have involved a great deal of hard work on the part of the secretary, will be heartily praised by the many who heretofore have been obliged to wait much longer for an opportunity to examine the official records of the convention. The indexing of the volume has been done with care and will probably satisfy all but the most exacting critics. The binding is uniform with that recently adopted by the Master Car Builders' Association and is a vast improvement over the old method. The press-work is by the Henry O. Shepard Company and is excellent.

THE RAILWAY SIGNALING CLUB.—Constitution, List of Officers and Members, and General Rules Endorsed by the Club to Govern the Operation and Maintenance of Interlocking Plants.

This little pamphlet is sent out to show the present standing of this comparatively new organization of signal engineers. Besides the constitution, by-laws and list of members, it contains what is believed to be the best codes of rules for the operation and maintenance of interlocking plants that have appeared. The members are practically familiar with signals and their appurtenances and are better qualified than any other group of men to formulate sensible rules for these purposes. It is not to be claimed that the rules are perfect, but they are the result of deliberation and discussion among the men best fitted to know the subject thoroughly. The little book ought to attract attention to the club, and it is to be hoped that encouragement will be given its members to continue the work which has been so well begun. It should be said of these rules that they will be found exceedingly useful to railroad officers who are compiling rules for their own roads, and they may safely be used as a basis for rules specially gotten up to meet the requirements of individual roads. The officers of the Railway Signaling Club are: W. J. Gillingham, Jr., Illinois Central Railroad, President; H. D. Miles, Michigan Central Railroad, Vice-President; E. M. Seitz, Chicago & Northwestern Railway, Secretary and Treasurer. The Committee on Rules is composed of Messrs. H. D. Miles, H. M. Sperry and W. C. Nixon.

CAR INTERCHANGE MANUAL. Abstract of Decisions of the Arbitration Committee of the Master Car Builders' Association, from January, 1888, to May, 1897. Compiled by J. D. McAlpine, Cleveland, O., 80 pp. *The Railroad Car Journal*, New York, 1897. Price, 20 cents.

This little book was prepared for the use of car inspectors and others who have to do with the application or interpretation of the M. C. B. interchange rules. It is a valuable guide for them and contains abstracts of decisions of the arbitration committee, including only such cases as are of practical interest at the present time. The book also contains an index, a list of synonyms, settlement prices for cars destroyed and its closing chapter is entitled "What to do in Accidents and Emergencies." It is a valuable book for all who are concerned with the rules of interchange of freight cars.

The August number of *Cassier's Magazine* is a special marine number. It compries 300 pages of special articles from well-known authorities on marine subjects and is handsomely illustrated. It gives pleasure to call the attention of our readers to it as an admirable presentation of the leading questions pertaining to modern marine matters. The mention of the names of Sir William Henry White, A. F. Yarrow, D. B. Morison, John I. Thornycroft, Archibald Denny, Walter M. McFarland, Leander N. Lovell, L. Meriam Wheeler, Joseph R. Oldham and John P. Holland as contributors is enough to say that this number should be obtained by everyone interested in marine engineering. The subjects are treated in such a thorough manner as to make it a valuable acquisition to any engineer's library.

KENT'S MECHANICAL ENGINEERS' POCKET BOOK.

Messrs. John Wiley & Sons announce that the third edition of this book has been issued and that all of the errors discovered up to the date of April 1, 1897, have been corrected. Errata slips may be obtained from the publishers by owners of the first and second editions. These are arranged so that they may be fastened into the books.

Trade Catalogues.

[In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. These are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

THE BUNDY GRAVITY AUTOMATIC PUMP.—The A. A. Griffing Iron Company, 66 Centre street, New York, has prepared a little pamphlet bearing the above title, a copy of which has just been received. It illustrates and describes the gravity pump and presents engravings and an explanation of its operation.

THE MERITS OF LEAD PAINTS AND DIXON'S SILICA-GRAPHITE PAINT COMPARED is the title of an interesting 18-page standard size pamphlet, the purpose of which is put by the publishers as follows: "Much has been said and written lately concerning protective coverings for iron structural work. The growing tendency among those who have given the matter careful consideration is to add some form of carbon to the red lead used, or to discard red lead altogether. This has caused the red lead manufacturers to issue pamphlets condemning the use of carbon—especially graphite. The statements of the red lead people have been so wide of the facts that we have made reply by issuing this pamphlet." The pamphlet is issued by the Joseph Dixon Company, Jersey City, N. J.

PRICE LIST NO. 12, by the Phosphor-Bronze Smelting Company, Limited, cancels former quotations of phosphor-bronze in the form of rolls, sheets, wire-drawn strips, circles, flat and square wire rods, sheets and screws.

COMPRESSED AIR FOR STREET CARS.—A little eight-page pamphlet containing statements of the adaptability, operation and cost of air power for street cars. It is prepared by the American Air Power Company, 160 Broadway, New York.

THE SMITH TRIPLE EXPANSION EXHAUST-PIPE FOR LOCOMOTIVES is described and illustrated in a little pamphlet which has been received from the General Agency Company, 168 Broadway, New York. The form and claims made for the pipe are set forth, and a convenient table is presented from which the number of revolutions per minute of any driving wheel of ordinary size may be taken at speeds between 5 and 75 miles per hour. The company also has offices in London and Chicago.

The Breaking of Staybolts.

The most marked change of the past few years in locomotives has been in the use of larger boilers and higher steam pressures. This applies to both simple and compound types, and the advantages of high pressures are likely to cause a further extension of their employment. A great difficulty introduced by these changes is an increasing amount of trouble from broken staybolts, which is now a source of anxiety to many mechanical officers and especially to those who have recently felt a sort of helplessness occasioned by the explosion of boilers which were frequently and regularly inspected and were supposed to be made of the best materials. The trouble is not confined to any particular type of boiler; crownbar, Belpaire and radial stayed boilers all show it, and he who will present a remedy will do a service that will be appreciated. The following paragraphs are presented with a view of summing up the evidence in the case in the hope that they may lead to a helpful discussion of the question:

Tests of all of the bolts in fireboxes are required regularly, and in some cases fortnightly, by motive power superintendents, and if these always exposed the bolts which are broken there would be no cause for anxiety, but, as shown by Mr. T. A. Lawes at the recent convention of the Master Mechanics' Association, in remarks printed elsewhere in this issue, it is the partially broken bolts that cause the greatest danger. Mr. Lawes shows that in 13 engines the proportion of bolts partially broken to those wholly broken was as 619 to 440, and he clearly outlines the necessity for precautions with regard to the discovery of the partial fractures, stating that: "A great risk is run by either not drilling the ends or using hollow staybolts and either of these precautions will prevent many boiler explosions with the usual verdict, 'Cause of explosion unknown.'" His remarks are well worth reading and they have been endorsed by a number of men in similar positions. The following extract from a letter from a very prominent mechanical officer is apropos:

The subject of broken staybolts is something that superintendents of motive power of this country cannot give their attention to too quickly. In these days of high pressure and severe engine service strict attention should be paid to proper inspection of staybolts. Our practice has been to examine our staybolts by hammer test every 30 days. About two years ago we adopted the practice of drilling our staybolts in one inch from the outside sheet. It then occurred to us that it would be an excellent thing to test our engines with the hammer test, and after the test was made to drill the bolts. We had the test made at once; it was very rigid and was made by various men, and when the inspector had declared that he had discovered all defective staybolts in the boiler we drilled the ends of the staybolts and then put on steam pressure and found as many as 58 bolts partly broken; none, however, that were completely broken, but the cracks in the bolts would be anywhere from a full half diameter to only only one-sixteenth holding together. This experience proved conclusively that there is only one way to be absolutely sure, and also proved that the hammer test, no matter how carefully or by whom made, would never indicate the bolts partly broken off, which to my mind are quite as dangerous, if not more so, than the bolts broken entirely off, because the latter we can discover by hammer test, while of the former we might have 20 or more grouped together and by giving way suddenly the others in the group would all go at once, perhaps resulting in an explosion or at least seriously bulging the sheet. Mr. Lawes, of the C. & E. I. R. R., in his remarks at the Master Mechanics' Convention, at Old Point Comfort, expressed our experience exactly.

In the hammer test a bolt that is broken entirely across may be expected to reveal its presence, but since every row of bolts has a different sound from every other row and every bolt has a different sound from every other on account of its location in the row, it is not strange that a partially broken staybolt should escape notice. There is less danger of missing them when the boiler is empty of water and when under a slight pressure. Diagrams are now in common use for recording the inspections and reporting the condition of boilers to the officers regularly. These diagrams often show interesting facts with reference to the location of the broken bolts. From a large number of records it appears that in long fireboxes on those of the Belpaire pattern, the greatest number of broken staybolts are found in the first two or three rows at the front and back ends of the box. Where there is a sharp compound curve in the side sheets the majority of broken stays occur in these bends and usually pretty evenly distributed along the whole length of the firebox. With crownbar boilers there seems to be less uniformity of breaking. The cost of renewals is not unimportant, but this side of the question is not the gravest one. If 20 are renewed per locomotive per year on one of the largest Western roads the number for all the engines for a year reaches 17,200, and for another large system the total number per year at the same rate per engine would reach 56,240, which shows that it is well to reduce the number of broken staybolts, entirely aside from the question of safety of boilers.

THE CAUSES OF BREAKAGE.

Staybolts break as a rule at or near the outer sheet. The explanation appears to be that of fatigue and repeated stress of the bolts due to the expansion and contraction of the inner firebox. Pressure has probably but little to do with it, since a ⅞-inch bolt supporting 20 square inches of sheet under 180 pounds' pressure per square inch has a factor of safety of 5. The stress due to steam pressure undoubtedly helps in the destruction, but is not one of the primary causes. Where the firebox sheets crack, the bolts do not seem to break and where bolts break, the sheets do not seem, as a rule, to crack, indicating that one or the other must yield to the expansion and contraction stresses. A difference of temperature of 200 degrees between firebox and shell sheets is reported to have been observed by Mr. A. J. Durston, Chief Engineer of the British Navy, and this authority also found a difference of nearly 350 degrees between the hot side of a ½-inch firebox sheet and the water on the other side of it when the sheet was incrusted with scale $\frac{1}{16}$ inch thick. This brings the temperature up to blue heat, which is a dangerous condition for wrought iron and steel, and probably hastens the destruction. The trouble caused by expansion and contraction is reduced by keeping engines constantly in service, which constitutes an argument favoring long locomotive runs; irregular service, however, such as working heavy grades, gives bad results due to the alteration of great and moderate heat in the firebox. Great strains occur during the kindling of fires, which become reduced as soon as uniform conditions prevail. The reasons for the breaking along the reverse curves in radial stayed boilers appear to be that the mud ring prevents motion at the bottom of the firebox, the tube sheet and crown staying stiffen the top portions and the location of least resistance is along the curves. This explanation would appear to be borne out by the frequent reports of cracked sheets near the mud ring. Here the stays are reinforced by the mud ring, and the yielding, such as there is, must come in the sheets. Where the sheets bend, however, the conditions are reversed and the bolts break.

One experimenter has said: "The difference of temperature between the outside and firebox sheets causes a difference in the amount of expansion, which by constant repetition wiggles the bolt in two." It is doubtless true that the cold air admitted to the firebox while firing has an important effect in connection with this wiggling.

In an elaborate series of tests carried out in 1892 on the Western Railway of France (See *American Engineer and Railroad Journal* 1894, p. 114), which included the measurement of the relative expansion of the firebox and shell of a locomotive boiler, it was discovered, that upon firing up a cold boiler the firebox expanded rapidly at first and five minutes after lighting the fire the expansion had amounted to 0.01 inch. The variations of the shell were very much slower and were not appreciable until 20 minutes after the fire was lighted. The movements of the firebox when the boiler pressure reached 156 pounds amounted to 0.19 inch. This looks bad for the staybolts, but the outside sheets expand when the water becomes hot, and at steam pressures above 128 pounds the expansion of the shell was the same in amount as that of the box. It is at the lower pressure and particularly before the water becomes heated that the severe staybolt stresses occur, and before the boiling point is reached there is a period in which the expansion of the firebox is five times that of the shell.

In these tests the maximum difference in the expansion was found when the boiler was under about 15 pounds' pressure. It then amounted to 0.1 inch and when the pressure rose the shell gradually expanded to match the movement of the firebox. It is well to observe that these tests were made upon a boiler much smaller than are commonly used in this country at the present time.

The number of repeated bendings of about one-eighth inch that staybolt material will stand varies from 1,400 to 93,600, and it is made plain by the tests which have been carried out that the method of making and fastening the bolts in the sheets has an important effect upon their life. It is hard for some to see how the repetition of bending should occur often enough in a locomotive firebox to fatigue the bolts. It is probable that the vibrations due to the roughness of riding has some influence, but the

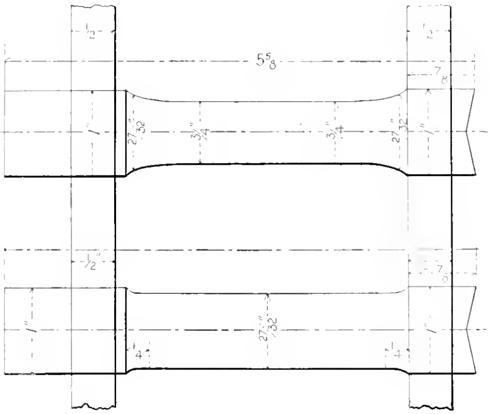


Fig. 1.

worst are those occasioned by the expansion and contraction of the firebox. If an engine is laid up twice a day long enough to allow the steam to run down, and this is repeated for 300 days each year, the bolts will receive at least 600 bends, and if an average of 2,400 bends is allowed for a bolt its life would be about four years. In actual practice with pressures of 190 and even 200 pounds, and with as much as three tons of coal burned per hour in a firebox, it is little wonder that the combination including "blue heat" should bring some of the bolts to end sooner than that. More light will probably be thrown upon the effect of vibrations on staybolts when the results of some experiments now in process are published. It is safe to say that the failures are due to repeated straining beyond the elastic limit by difference in amount of expansion and contraction of parts of the firebox. The stresses produced by these causes are enormous. Experiments made in England with fireboxes slightly corrugated, and somewhat more easily compressed than straight ones would be are said to have shown that 600 tons pressure was required to shorten a firebox 2 feet 6 inches diameter by $\frac{1}{32}$ inch. As to the matter of blue heat it is well to observe that steel having an elastic limit of 35,000 pounds at zero degrees has its elastic limit reduced to 20,000 pounds at 600 degrees Fahr.

POSSIBLE REMEDIES.

A number of suggested remedies will be briefly noted:

The use of sharp dies and loose fits of the bolt-threads in the sheets have been tried with indifferent success. It has been urged that stays should be screwed home with small hand wrenches and the dies should be renewed often enough to make this method possible. Also, that there is no reason why staybolts should fit tight on the bottom of their threads, and that turning off the threads on the taps, so as to get a round thread in the sheets against the bottom of the threads on the bolts, would leave the bolts sufficiently loose to let them wiggle enough to relieve the bolts from bending. No record is known of this having been tried. It has often been noted that loose bolts stand better than tight ones. A sharp V thread is a bad one for this purpose, the Whitworth is better, but a rounding off of the tops of the threads in the sheets is probably the best form of threads to be used. This tends to prevent the bending of the bolt across the sharp edge of the sheets and prevents any "jam" in the action of the thread in the sheet. The trouble with loose bolts, however, is that they do not stay loose, but corrosion cements them fast after a short time.

The sheets of fireboxes have been thickened and the staybolts have been somewhat shortened with the increase of steam pres-

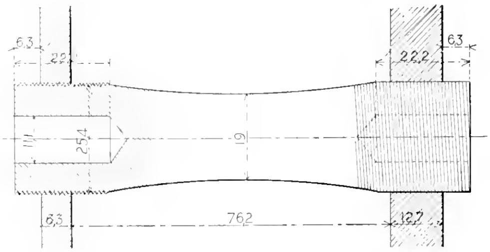


Fig. 3.

sures and this results in the sheets being stiffer than the bolts and the bolts yield first. It is urged that if staybolts are increased in diameter and consequently in stiffness a balance might be obtained, but it is questionable whether this could be done, even if they were increased to 1¼ inches in diameter. From experimental work it appears that increasing the diameter of the stays increases the bad effect of the vibrations. An increase in the number of stays would appear to be equally futile.

More attention has been given to rendering staybolts flexible than to any other remedy and several methods of doing this are illustrated in the accompanying engravings, the object of these being to prevent the localization of the bending by distributing it over the whole length, or by providing a joint at the outer sheet which might yield to side motion. Fig. 1 is a diagram showing

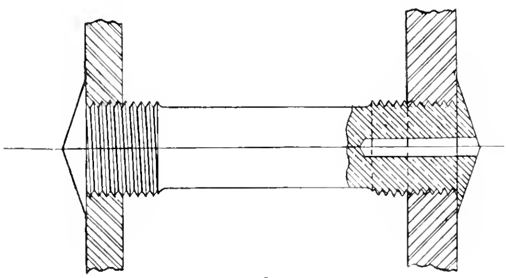


Fig. 2.

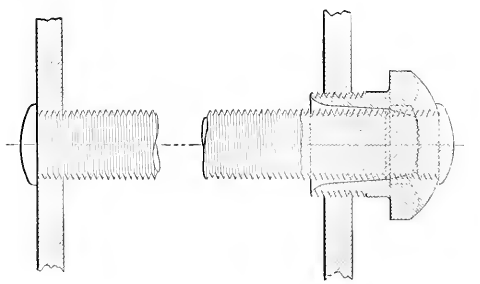


Fig. 4.

a form of stay now being tried in one firebox of the Boston & Albany Railroad, from which good results are expected. The form shown in Fig. 2 is that used by the Baldwin Locomotive Works in all locomotive fireboxes. The form given in Fig. 3 is used on the Great Eastern Railway of England in connection with steel fireboxes and shells. Fig. 4 is a flexible staybolt designed by Mr. Joseph Nixon, foreman of the boiler shops of the Pennsylvania Railroad at Altoona. This illustration is reproduced from the September, 1896, issue of this journal, in which the attachment was described in connection with the Altoona shops. This consists of a nut with a tapered thread 1⅝ inches in diameter which is screwed into the outside [plate of the firebox. The hole on the

inside of the nut is tapered, and "runs off to nothing," in the thread which is cut in the outer end of the hole. The point of flexure is thus distributed over some distance. This plan was first tried in 1892 and is found satisfactory, as was noted in the description referred to. In Fig. 5 an

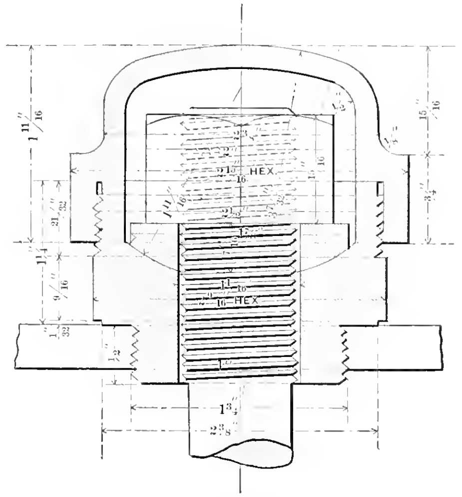


Fig. 5.

expansion staybolt attachment is shown as applied to the Pennsylvania class L engines and was illustrated in this journal, issue of August, 1896. This arrangement is applied to crown stays and it allows them to pass upward through the outside sheet when the inner box expands. The method of preventing the escape of steam is made apparent in the drawing. The Yarrow system is illustrated in Fig. 6. This form was used a number of years ago in some fast passenger engines for the Swedish state railroads. The design is clearly indicated by the engraving. The last two forms are used on crown stays, and only then in the places where the greatest movement occurs. They have been found satisfactory, but the objection of high first cost has been raised against them. The use of longer bolts for staying side sheets has been advocated, but inquiry shows that this is not always successful. It is true that comparatively few crown stays break, but it is difficult to lengthen the side stays to any extent. Somewhat longer bolts might be used at the reverse curves, but the arrangement used on the Pennsylvania appears to provide a better method. Greater water space and straighter side sheets, with fireboxes above the frames, would be an improvement, but it is stated by one who has tried it that merely lengthening the staybolts even to a length of 8 inches will not alone prevent their breaking.

Copper is extensively used for firebox sheets and staybolts in foreign practice with steam pressures as high as 214 and 220 pounds, and there seems to be less trouble there with broken stays. This brings up the question of material. Copper sheets and copper stays yield more readily than steel and iron, and if we cannot use copper with success, nickel steel is worth considering. It has been suggested that nickel steel might be used both for plates and for staybolts. Thinner plates could be employed if of a stronger material than that now used, and their flexibility would probably favor the bolts to some extent, but probably more satisfactory results would follow the experiment of making the staybolts of this material. Nickel steel has been given a cordial reception by engineers because of its toughness, its strength and high elastic limit, its resistance to corrosion, its ability to resist a large number of alternate stresses, and its favorable method of breaking. It does not seem to develop cracks and follow them out to complete fracture, but tears instead. All of these features appear to give this metal interesting qualifications as a staybolt material. The British admiralty have recently brought out some interesting points in favor of nickel steel, but these can only be alluded to here. Landis says: "When the boiler is made entirely of nickel steel, thus preventing electrolytic action, there is no doubt that it is the best material yet applied to that purpose." Its elastic limit is about equal to the tensile strength of ordinary boiler steel, which explains its ability to resist repeated stresses. It is stated that where a low-carbon steel of 0.20 per cent. carbon will stand 300,000 repeated stresses on an alternate

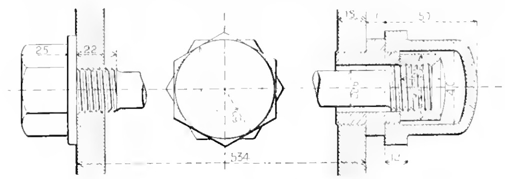


Fig. 6.

stress machine, and a steel of 0.50 per cent. carbon will stand 400,000 repeated stresses, nickel steel will stand from 1,500,000 to 2,000,000 repeated stresses, each of which is about two-thirds of its ultimate strength, or very near its elastic limit.

Thirty-eight years ago Mr. James Milholland appreciated the trouble under consideration and tried a scheme to relieve staybolts by indenting the sheets around them. This, he says, places the iron in such a shape in the sheet as to allow it to spring when the expansion of the sheet and staybolt takes place.

A plan for accomplishing about the same thing has recently been tried on the Chicago, Rock Island & Pacific Railway, and is shown in Figs. 7 and 8. This consists in cupping the side and back firebox sheets at the staybolts after the manner indicated by the sketch. This was first applied by Mr. George F. Wilson, Superintendent of Motive Power of the road mentioned, about two years ago. Of this plan Mr. Wilson says: "I arranged to have half the firebox cupped and half straight or flat in the usual way. The engine was then put in service on a district noted for its bad feed water. It did not take long before the usual trouble with leaking staybolts occurred, but only in half of the firebox, the side with the straight plate. The side where the sheet was cupped

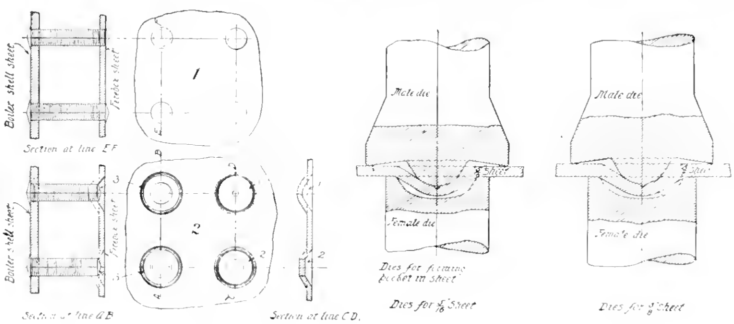


Fig. 7.

did not show a sign of leak or weakness, and, up to date, this side is as tight as when the firebox was new. Encouraged by the good result, I had the firebox sheets in a number of boilers 'cupped,' and in every instance with satisfactory results."

This plan appears to give the desired results. It has been patented in the United States and Canada, and, according to these experiments, it improves fireboxes to an extent that more than pays the cost of cupping. Mr. Wilson believes that if the cupped firebox, properly made, is tried in cases where trouble has been found, the result will convince the most skeptical.

Hollow and drilled staybolts tend to reduce danger from the fact that they reveal the existence of fractures which are sufficiently deep to open into the hole in the bolt. The holes when drilled are usually not more than 1 or 1½ inches deep and the comparative merits of drilled and hollow bolts are very well expressed by a committee of the Southern and Southwestern Railway Club in 1893.

The superiority of the hollow over the drilled stay is due to the fact that the hole runs the entire length through and the flexibility is equal to the entire length whereas drilling a hole at the outer end of the stay, say 1 inch or 1½ inches in depth, weakens the stay at a point where it has a tendency to break anyway.

The holes when free clear through the stays not only permit of the escape of steam when a bolt breaks, but also keep the temperature down below the blue heat. It has been urged that the holes will fill up and defeat the object of the hollow stays, but this cannot be considered serious. The holes may be easily cleared by air pressure or by running a drill into them. Hollow stays made by drilling a $\frac{1}{4}$-inch hole entirely through have been used in France for a number of years on the Paris-Orleans, the Paris, Lyons & Mediterranean, the Eastern and the Northern railways. The practice on the Roumania State Railway has been to drill a $\frac{3}{16}$-inch hole and plug it on the inside end of the staybolt. As to wearing qualities the hollow stay seems to stand repeated bending better than the solid one and the following quotation from the report of the committee of the Southern and Southwestern Railway Club previously referred to is a strong recommendation of this type.

The committee also obtained samples of hollow staybolt iron which stood a strain of 49,000 pounds with 45 per cent. elongation and 52 per cent. reduction of area. The $\frac{7}{8}$-inch stay made of this iron having [illegible]-inch hole rolled throughout its entire length broke at 63,720 $\frac{1}{8}$-inch strokes, but when the center was turned down to a diameter of $\frac{3}{4}$ inch this hollow staybolt made of the same iron, stood 93,600 $\frac{1}{8}$-inch strokes before breaking—a very remarkable performance. . . .

The committee believes that hollow staybolt iron should be used, that the thread should be the U. S. standard, 12 threads per inch; that the inner ends of the holes should not be opened after the stays are headed up, but that the outer ends of the holes should be kept open; that $\frac{7}{8}$ inch stays should be turned down between sheets to a scant $\frac{3}{4}$ inch. . . .

An inspection which may be made at any time with steam up, by any inexperienced person which is as definite and positive as is the case where hollow or drilled stays are used is to be preferred to the uncertain methods of sounding now in use. . . .

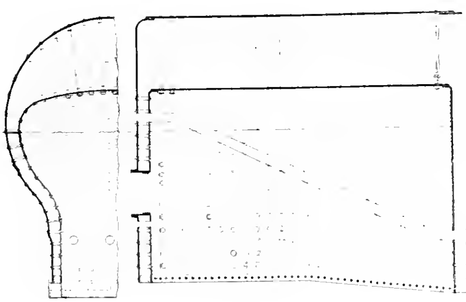


Fig. 8.

Stayless boilers will, of course, do away with broken stays and there are signs of increasing interest in designs which will stay themselves. In marine practice corrugated furnaces are successful to a degree offering considerable encouragement for their employment in locomotives, at least as regards their wearing and resisting qualities. We have in stationary practice a record of a Morison Suspension furnace made by the Continental Iron Works, Brooklyn, N. Y., which worked for 10 years under a pressure of 100 pounds without a dollar's worth of repairs. It was not forced, and even marine boilers are not forced as locomotive boilers are, yet there are good reasons to believe that corrugated furnaces ought to be given an opportunity of showing their adaptability in this work. Mr. G. W. Cushing in a recent communication says: "The discussion of the subject of broken staybolts reminds me of the Strong internally fired corrugated furnace as adapted to the locomotive. This type dispenses altogether with stays and, of course, eliminates all danger from this cause." The sphere and cylinder are the only forms which do not tend to change shape under pressure and cylindrical furnaces are theoretically sound. There may, however, be some difficulty in obtaining sufficient grate area unless the furnaces are double. About eight years ago the Lentz stayless boiler was brought out on the Prussian State Railways. The Strong boiler has been in use for about thirteen years in this country, and this type of firebox appears to deserve further experimental application for large high-pressure locomotive boilers. The brick-lined firebox is thought by some to have strong qualifications, and it is highly probable that the water-tube principle will soon be tried experimentally on locomotives.

One of the prominent Western roads is about to try an old but apparently sensible plan of putting several corrugations of a depth of about $1\frac{1}{2}$ inches into the fireboxes of a number of new engines. The corrugations will be at about 18 inches centers, and the suggestion was taken from an old firebox that had been made with corrugations of a depth about equal to the thickness of the sheet. The engine having this sheet on one side of its firebox came in for repairs, and the wavy sheet was good while the other had to be renewed.

This article is not an attempt to offer an original solution, but rather to sum up the troubles, their causes and possible remedies, with a view of bringing together the various suggestions that have been made. Staybolt breakage is not believed to be unavoidable, and it appears comparatively easy to detect partially broken bolts by the use of hollow ones. From the foregoing it is also apparent that when good material is used in the hollow form the resistance to the destructiveness of vibrations is exceedingly high. It is clear that locomotive boilers should be kept "hot" as continuously as possible, and this will be favored by the present tendency toward increased locomotive mileage, and, finally, it seems advisable that the advantages claimed for stayless fireboxes with regard to freedom from troublesome repairs to sheets and stays, as well as increased freedom of circulation, should be determined before the corrugated furnace is set aside as not applicable to locomotives. The present form of locomotive boiler can not be claimed to be a model of engineering design. It is the result of what may be called compulsion, and it is not unreasonable to believe that improvements may be made in it and that even a radical change in design may be brought about.

A Russian Canal.

Consul Monaghan sends a communication from Chemnitz to the State Department in which he says:

A deep and long canal is to be built by Russia to connect the Baltic with the Black Sea. This stupendous project indicates the giant aims of the great empire. The canal, as projected, is to connect Riga, on the Baltic, with Cherson, on the Dneiper near the Black Sea, is to be 1,000 miles long, 213 23 feet wide at surface, and 115 feet at the base, with a depth of 27.9 feet. It is to carry easily the biggest battleships of the world. From Riga, the canal is to run into the River Dvina, thence by canals from Dvinaburg to Lepel, through the Beresina and Doeiper to Cherson. It is further projected to cover all the river regions with such a network of canals as would aid very materially in developing the whole surrounding country. Ships that went hitherto by way of the Atlantic, Mediterranean Sea, and Marmora Sea, taking more than 12 days, will need now less than six days. Basins are to be built near Pinks and harbors at all important points along the canals.

Traffic is to be carried on day and night at a possible or permitted speed of about seven miles an hour. The cost of the canal is put down at $95,200,000. It is to be ready for traffic in five years. Surely some, if not all, of the dredging and canal machinery of the United States is much more easily handled and better adapted to such work than are those of this Empire. Even here, the vast superiority of our tools is admitted. The only objection made is to their prices. The market in Russia grows more and more interesting. The share we are to have in it will depend upon ourselves.

Electric Car Lighting from the Axle.

The beauty of the incandescent electric light for the illumination of railroad cars has caused a large number of experiments for the purpose of developing a satisfactory equipment of apparatus. Europeans have spent much time in experimenting with storage batteries, and they appear to have been successful in a plan which involves changing the batteries at the end of each run. Special electric plants are used, and the batteries are handled upon trucks for which narrow-gage tracks are laid from the yard to the electric plant. A somewhat similar plan has also been used to a limited extent in this country.

Direct lighting from dynamos in this country has been successful as far as the operation of the light is concerned. Such plants include auxiliary engines placed in baggage cars or in special cars provided for the purpose. The objection to this is the cost of operation, considerable attention being required for such a system. For a long time efforts have been made to utilize the axles of cars for driving dynamos, one of the advantages of a system operated in this way being that power thus obtained would be cheap from the fact that the dynamo would take some of the power now wasted in the stopping of trains, and in suburban work this is a large item. Another advantage is that little attention would be required for such an arrangement. Storage batteries are necessary in this case because of the stopping of the trains, and altogether there have been many mechanical difficulties in the way of success.

The National Electric Car Lighting Company of New York has perfected a system which is now beyond the experimental stage, and has been in successful use long enough to establish confidence in its efficiency and low cost of operation. The originator of the system is Mr. Morris Moskowitz, to whom the design of the dynamo and the regulating devices is due. A car equipped with this system was put into regular service upon the Atchison, Topeka & Sante Fe Railway in October of last year, and it has made a most satisfactory record. The road has contracted for 50 cars to be fitted with the system, and these will soon be running. The only attention given to the lighting equipment is what it receives from the train crew and it has been demonstrated that the cost of operation of the

system has not been more than that of an ordinary outfit of oi lamps. This car has 14 16-candle power lamps, and two of 8 candle power. The company has an option for 150 additional cars after the equipment of the 50 now under contract.

The light is obtained from a dynamo attached to the car truck, and driven by a camel's hair belt from a split pulley on one of the axles. The proper arrangements for accommodating the vertical movement of the axles are provided, and it is found that a belt such as is now used is good for about 40,000 to 50,000 miles of service, and that no trouble is experienced by reason of snow or rain blowing under the car. A special form of belt joint is used which keeps the joint itself away from the pulleys, and greatly increases the life of the belt. When the car is running in regular service the dynamo and storage battery furnish light sufficient for about 12 hours of lighting per day, and the accumulators will light the car for 12 hours continuously if the car should remain standing. The dynamo may feed the light directly, and send the surplus into the accumulator, but does not begin to generate current until the train has attained a speed of eight miles per hour, and variations in speed do not seem to affect the quality of the light in any way. The regulation is automatic, and the only attention required on the road is to turn the light on or off. The usual method, however, is to feed one-half of the battery from the dynamo while the other half is furnishing light. The arrangement of the controlling devices is so simple that the running directions may be placed on a 2 by 6 inch metallic tablet on the switchboard. The chief features of the system are the dynamo, the battery of accumulators, a switchboard with the automatic regulating devices and the lamp circuit.

The dynamo is encased so as to be dust and moisture proof and it is so placed upon the end piece of the truck frame as to be easily accessible. Oiling devices for carrying a week's supply of lubricant are provided and the dynamo brushes are manufactured specially for this work with a view of giving a service of several months. The dynamo regulates itself and it is wound so that the current is only three volts higher at a speed of 60 miles per hour, than it is at eight miles. A main switch controls all of the circuits of the dynamo and it must be closed to cause the dynamo to generate. It may be opened at any time when the train is standing to stop the generation. Another simple switch controls the main lighting circuit and a 12-point switch controls the whole system. The switchboard also bears electro-magnetic devices, whereby the poles are automatically changed to correspond to the direction in which the car may be moving. Provision is also made for automatically opening the main circuit between the dynamo and storage battery by the difference in voltage between them. A device recently patented has been added to the equipment to regulate the charge and discharge of the battery in such a manner as to prevent them from being either charged or discharged beyond their capacity. This company has contracted with the Electric Storage Battery Company for five years for what batteries it may require in that period.

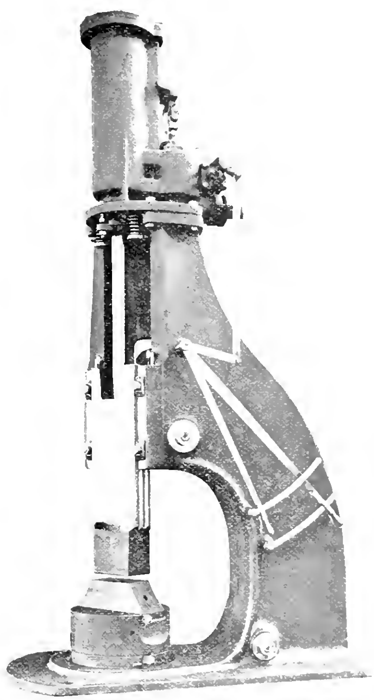
Attention is called to the fact that when the speed of the train is rendered by heavy grades slower than eight miles per hour, the dynamo will take no power for generating, and under ordinary speeds the power required to operate the dynamo is so small that it cannot be measured or noticed in the operation of the train. Another excellent feature of the system is that a single dynamo may be used to light several cars. It is understood that the company is prepared to undertake large installations, and that when applied to sleeping cars the Gibbs patent berth lamp will be used. The chief claims for the system are its reliability and low cost of operation, and while its first cost may seem to be high, the ultimate cost is believed to be favorable to this system above that of oil lighting, and the excellence of the lights is an additional advantage. The President and active officer of the company is Mr. Max E. Schmidt, C. E., who is well known as formerly Chief Engineer of the Mexican Central Railroad and as Chief Assistant Engineer under Captain Eads in the Mississippi jetty work in 1875. Mr. Hiero B. Herr is the General Western Agent of the company, with office in the Monadnock Building, Chicago. The organization is a strong one, having all of the capital necessary for very large contracts.

A New 3,300-Pound Steam Hammer.

The steam hammer shown in the accompanying engraving was built to the special order of Mr. G. W. Stevens, Superintendent of Motive Power of the Lake Shore & Michigan Southern Railway. It was built by Bement, Miles & Company, and the requirements provided that it should be adapted to the various work necessitated in locomotive repairs. It was to have sufficient stroke and weight for expeditious work in welding jaws on locomotive frames and to have sufficient delicacy in operation to permit of its use on light work.

The cylinder is 15 inches in diameter by 42 inches stroke. The distance from the lower die to the lower end of the ram guides is 35 inches, and from the center of the ram to the inside of frame is 39 inches. The ram and guides are set diagonally to the frame at the proper angle for drawing and finishing. The guides are made adjustable so as to provide for taking up the wear of the ram. Elasticity in the frame is obtained by dividing it between the cap and base, and then bolting together with heavy bolts provided with cupped washers. The base of the frame is stiffened by heavy ribs below the floor line.

The valve gear is arranged with the least possible number of moving pieces, and takes up its own lost motion by gravity;



A 3,000-Pound Steam Hammer.

Bement & Miles.

hence it will control the hammer with great uniformity for a much longer time than would otherwise be possible. Having no connection with the ram, it escapes all concussion. It is so designed as to produce, automatically or by hand, every variation in the length, position or force of the blow. The valve itself is of most simple construction, is perfectly balanced, and takes steam both above and below. The piston can be raised above the top of the cylinder for the examination or renewal of packing block rings without disconnecting the rod from the ram. The anvil is made so that the die can be easily removed for repair or replacement without removing the whole anvil.

A copy of a letter to the builders, signed by Mr. Stevens, shows that the requirements have been met admirably.

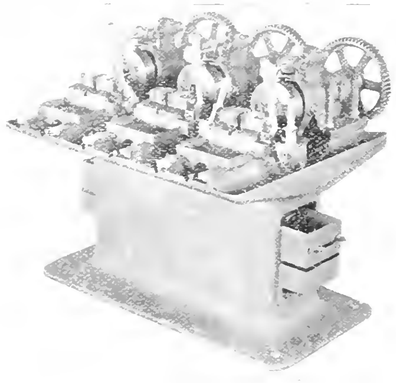
Eight-Wheel Locomotives for the St. Lawrence & Adirondack Railway.

The Brooks Locomotive Works have built three eight-wheel passenger locomotives for the Adirondack & St. Lawrence Railway to be used in the tourist business of that road. The boilers are of the Player patent, Belpaire type. The crank pins are hollow, and the piston rods are extended through the front cylinder heads. Cast steel has been used liberally, and the boiler fronts and smokebox doors are of pressed steel. The general dimensions of the design are as follows:

Weight in working order	122,300 pounds
Cylinders	18 by 26 inches
Driving wheel centers	Pratt & Letchworth cast steel
Tires	Latrobe open-hearth steel
Engine truck wheels, cast steel, steel tired	28 inches diameter
Outside diameter at smallest ring	60 inches
Working pressure	200 pounds
Boiler covering	Magnesia sectional
Firebox, type	Sloping over frame
Firebox, length	107⅝ inches
Firebox, width	40⅞ inches
Tubes	274, 2 inches diameter
Total heating surface	1814.16 square feet
Grate surface	30.4 square feet
Tender wheels	33 inches diameter, National
Tender frame	Square channel steel
Water capacity	4,200 gallons
Coal capacity	8 tons

The Acme Triple Bolt Cutter.

The engraving illustrates one of two sizes of triple bolt cutting machines, manufactured by the Acme Machinery Company, of Cleveland, O. They have sufficient capacities for cutting bolts from the smallest diameters up to those of one and one and one-half inches respectively. They are specially designed for manufacturing purposes where extensive duplication of work is practised. The wearing parts of the heads are protected by hardened tool steel for the purpose of resisting wear, and dies of very simple construction are used in them. These manufacturers give special attention to the production of bolt cutters, nut tappers, bolt headers and forging machines. The office of the concern is corner Belden and Hamilton streets, Cleveland, O.



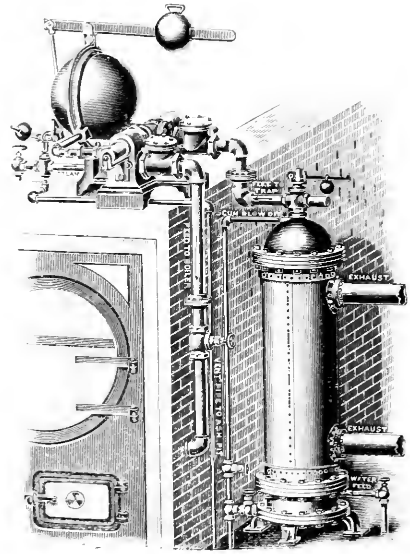
Acme Triple Bolt Cutter.

Elevated Railroads and the Brooklyn Bridge.

The contracts between the trustees of the Brooklyn Bridge and the elevated and trolley railroads of Brooklyn have been signed, which means that the elevated railroad trains and trolley cars from Brooklyn will probably be running over the bridge into New York within six months.

The Bundy Gravity Pump.

The Bundy gravity pump is so called because it operates by gravitation and feeds water to a tank or boiler after the manner of a pump. It consists of a gourd-shaped bowl which moves up and down on its fulcrumed axis. The distance traveled is short, its sole function being to open and close a balanced valve, which, when open, allows the pump to discharge and when closed allows it to fill. When the bowl is full of water the weight of the water causes it to settle in the frame and discharge. When empty the bowl is raised in the frame by the ball weight which is placed on the lever at the proper distance to counterbalance and return the empty bowl. This ball may be adjusted to give the desired power and amount of opening to meet any varying condition that may arise. In this arrangement the weight of the bowl and the water in it does not act directly upon the working parts, and since the No. 211 gravity pump bowl holds 60 gallons of water, weighing 500 pounds, the importance of this provision is readily apparent. Underneath the bowl is a stop upon which the bowl rests when discharging. This stop may be adjusted to give more or less motion to the bowl; this, however, is provided chiefly as a matter of convenience, as it has no direct bearing upon the working of the pump. Under the equalization valve is an air valve which is open while the pump is filling and closed while it is discharging. It is practically the exhaust outlet, and through it the air escapes from the system when starting up.



The Bundy Gravity Pump.

During the period of filling the pump is open to the atmosphere through the vent pipe or exhaust, but while discharging it is closed. At each filling and evacuation of the pump a pair of check valves alternately open and close. The check valve in the supply to the pump is open while the pump is filling, the other check valve being closed by boiler pressure. The check valve in the supply to the boiler is open while the pump is discharging, the other check valve being closed by boiler pressure of the water, which has entered the boiler through the equalizing balance valve. The water enters the boiler by gravity, for the pump is placed three feet above the water line of the boiler and has equal pressure with it.

The pump feeds water to boilers from either open or closed feed-water heaters, also returns condensation from all sources. It will pump cold water noiselessly from city supply, tank or pond, the only requisite being to get the water to the pump, which may be by gravity or a pressure of one pound for each two feet of lift. An interior view would disclose no undescribed parts, as the bowl is entirely empty. The balance and check valves are of standard pattern, but made with a view of durability and strength. The full size of opening is maintained from the inlet to the outlet of the pump to insure maximum capacity

In pumping to an elevated tank compressed air may be used

instead of steam, the connection being the same in either case. With 50 pounds pressure of either air or steam water may be raised 140 feet, less the proper allowance for friction. It may be used for pumping water out of cellers or sewers or for filling water tanks on railroads, in which capacity it is claimed to be very efficient.

The A. A. Griffing Iron Company, 66-68 Center street, New York, will furnish any additional information in regard to this apparatus.

Electricity as a Motive Power on Elevated Railroads.

BY S. H. SHORT.

An elaborate and interesting paper has been received from Mr. S. H. Short, with a large number of illustrations, and we regret that lack of space prevents its publication entire. The text nearly in full and representative diagrams are given below.—EDITOR.]

The elevated railroads of New York, Brooklyn and Chicago were built to satisfy a crying demand for rapid transit from the business centers to the suburban districts of these great cities. So long as they had for their only competitor the slow-moving horse car they were considered a great convenience, notwithstanding that one was obliged to walk from one to three blocks and climb a difficult flight of stairs to reach these rapidly moving trains.

Since the "trolley car" has come into general use people have been educated to a still more rapid rate of travel, and where the trolley car parallels the elevated railroad, as in Brooklyn and Chicago, the frequent, speedy and accessible surface car is by far the more popular. In New York, however, the elevated railroads still enjoy a very large traffic, because the electric cars do not parallel their lines, nor are the facilities for transportation yet sufficient for the enormous masses to be moved back and forth in that city. However, the surface lines are soon to be equipped electrically and their carrying capacity thereby enormously increased, to the detriment of the elevated railroad travel. In order to retain their traffic it will be necessary for the elevated railroads to move their trains more frequently and at a much greater rate of speed to compensate the traveling public for being obliged to walk some distance and climb those disagreeable stairs.

The elevated roads are all built on the same general plan, the structure being provided with double track throughout the entire length, with station about $\frac{1}{3}$ mile apart. The grades are slight and the curves of not less than 90 feet radius. The structure is made to safely carry the standard elevated train, i. e., five passenger coaches, each 46 ft. in length, weighing, when loaded with 75 passengers, 20 tons, drawn by a locomotive weighing $23\frac{1}{2}$ tons, making a total of $123\frac{1}{2}$ tons for the complete train.

The locomotives are constructed so that 65 per cent. of their weight, or $15\frac{1}{4}$ tons, are upon their drivers, giving an adhesion and, therefore, a maximum horizontal effort for accelerating the train of 7,650 pounds. This effort is used for accelerating the train for 50 or 6 seconds and a speed of 20 to 25 miles per hour is attained while a maximum of 300 horse-power is developed by the locomotive. The brakes are then applied with a negative acceleration and the train is brought to a standstill at the next station, where it remains on an average 13 seconds.

In the accompanying diagrams, Figs. 1 and 2, I have illustrated graphically the performance of one of these trains, between stations, also the consumption of power as calculated from the weight and speed of the train. It will be seen therefrom that it is not possible with steam to make a better schedule time than is at present in force, i. e., $13\frac{1}{2}$ miles per hour, unless the weight of the locomotive be increased or the trains be lightened. The heavier locomotives would endanger the safety of the entire structure. The lighter loads would necessitate more frequent trains, consequently a much larger force of skilled employees to run the extra locomotives. The cost of fuel for operating a steam locomotive amounts to about 20 per cent. of the total operating expenses of these roads, the fuel consumption being about 7 to 8 lbs. of coal per horse-power per hour.

With good compound condensing engines driving electric generators at a station, the coal consumption is reduced to about one-third of that amount.

Were steam locomotives discarded it would be possible to replace the high priced skilled labor necessary for their operation by ordinary trustworthy men who are not skilled mechanics; whose rate of wages is about one half that of a locomotive engineer, and only one man would be necessary to operate the electrical propelling mechanism. We believe the repair account will be materially lessened both in the units of motive power and in the permanent way were the trains equipped with motors. The care of a steam locomotive is very onerous, the average run being only about one hundred miles, when it must be thoroughly overhauled and inspected by skilled mechanics before being used again. Contrast with this the all day service of most electric motors two or three hundred miles a day for days and weeks, without inspection, cleaning or care of any kind.

The standard electrical equipment for an elevated train consists of the present elevated car, provided with two swiveled trucks of special construction arranged to receive electric motors of a type adapted especially for this service. The wheels of the trucks are 33 inches in diameter, and the wheel base does not exceed 6 feet for the largest motors, and is reduced to 5 feet 6 inches where motors of the smaller size are used. The weight of the motor car loaded to its full capacity with passengers is 32 tons, including trucks, motors and the electrical equipment. In most cases it is advisable to use only two motors upon a motor car, and both should be placed on one truck for convenience in repairing. There is, therefore, $19\frac{1}{2}$ tons upon the drivers, or 61 per cent. of the total weight of the motor car, which corresponds favorably with the percentage of the total weight of passenger locomotives upon their drivers. This gives an adhesion and, therefore, a maximum practical horizontal effort for the motor car of 9,750 pounds, or a total possible horse-power of 400 in accordance with standard motor rating.

This pair of motors is, therefore, capable of accelerating a train of three standard elevated cars at the rate of 1.85 feet per second, and of making a schedule of $16\frac{1}{2}$ miles per hour, including stops, as illustrated graphically by the accompanying diagram (Fig. 3).

If the other truck of the motor car is also equipped with motors, a train of double that size will operate in exactly the same manner.

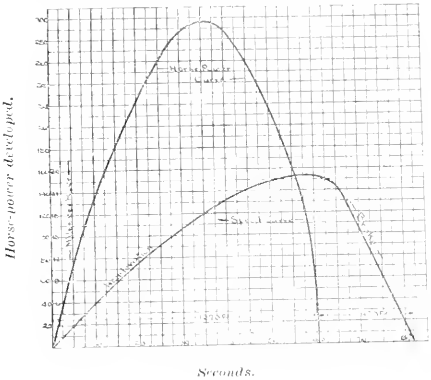


Fig. 1.—Present Manhattan Elevated Train—Ninth Avenue, Sixty-sixth to Fifty-Ninth Street—1,800 Feet.

and one more car may even be added, because the tractive effort required per ton decreases materially as the number of cars in the train increases, there being but one motor car on the train. It is not advisable to use more than two motors, owing to the complications which arise in the controlling devices.

The requirements of the service to be rendered on the different elevated railroads necessitates very careful consideration being given to the size of the motor to be used upon the different roads. There seems to be no question about the advisability of using as large a motor as possible upon a road like the Sixth avenue in New York, where the travel is constant throughout the day, and trains of from four or five cars can follow each other at short intervals all day. But in Brooklyn and Chicago, where the traffic is heavy during short periods of time, and light during a larger part of the day,

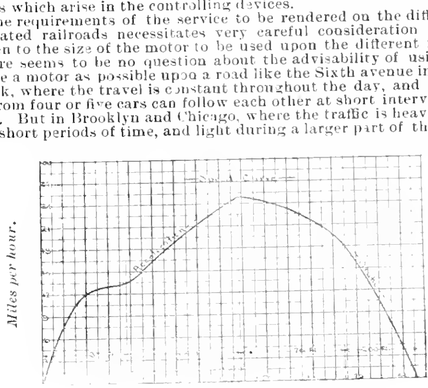


Fig. 2.—Present Manhattan Elevated Train—Ninth Avenue, Twenty-third to Fourteenth Street—2,320 Feet.

it seems desirable that trains of few cars, or even single motor cars shall be run at frequent intervals without a printed time-table, thereby practically securing a high speed street car service on the elevated structure.

Another reason for frequent and light trains is that these roads have branches, which by this method would be served to better advantage.

It is possible also that these single motor cars or short trains may be coupled into longer trains during the rush periods of the day and be operated from the front platform by one motorman, if a suitable controlling apparatus is provided, by means of which all of the motors of the train can be simultaneously controlled.

A motor of much smaller size than would take up the full adhesive power of the truck could be used where this method of equipment is adopted. It, however, has the disadvantage of multiplying the electrical apparatus necessary to move the rolling stock of the road. It will also consume more power per ton miles of train because the tractive effort per ton of the trail cars is about half that required by the motor cars, the difference being due to the friction, windage, etc., of the motor cars.

For the convenience of engineers making calculations for the re-

quired current in amperes at 500 volts pressure, which will be necessary to operate a given line of road with trains as specified above, we give a table showing the maximum current consumed by trains during accleration; the current necessary to operate the trains at full speed and the average current and horse power for the various trains.

CURRENT CONSUMED BY TRAINS OF STANDARD ELEVATED CARS.

Number of cars.	Accelerating current.	Full speed current.	Average current.	Average horse power.
1	200	90	180	131
2	500	175	227	152
3	780	190	348	231

MOTOR BEST SUITED TO ELEVATED SERVICE.

There being neither dust nor water to contend with, the motor can be left entirely open for the free circulation of air over the armature and field magnets, and not only thorough ventilation but 20 per cent. more output can be obtained from a given machine in this way. The open motor can be much more easily inspected and kept free from oil and grease.

This motor is intended to be taken apart by running the truck from under the car, and lifting the upper half of the magnetic ring by means of an overhead crane; this exposes the armature, left with its bearings in the motor frame, which is journaled to the car axle at one side and supported by the truck bolster at the other side. The motor frame has cast integral with it the lower half of the magnetic ring. Each half of the magnetic ring has two pole pieces, wound with a few turns of heavy copper ribbon, so that the

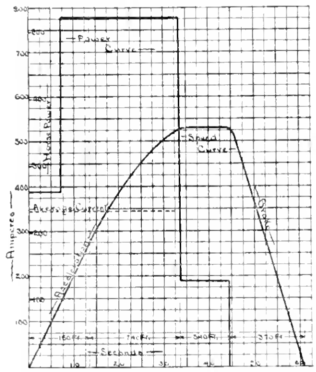


Fig. 3.—74-Ton Train—200 Horse-Power Motors—Schedule 16½ Miles an Hour—1,800 Feet between Stations.

magnetic system of the motor is symmetrical, and of very large sectional area, to provide for the rapid acceleration control, which will be discussed later.

The magnetic ring is large in diameter and the axle is made to pass inside the ring, between the magnetic coils, so that the distance between the gear centers is short. This makes the gears small in diameter and gives a large clearance above the stringers inside the rails.

The armature is especially large and heavy, provided with deep slots to secure the bar winding, which makes but one turn per commutator bar. By this means the self-induction of the armature windings is reduced to a minimum, and there is a very low voltage between the commutator bars, providing for perfectly sparkless commutation. Bronze is used for both the armature and axle bearings, and the lubricant is oil instead of grease. The brasses are so arranged that the thrust caused by the gears brings the shafts against solid, unbroken surfaces. The oil is stored in cellars and is carried to the bearings by means of waste which wipes the entire length of the shafts within the brasses. Provision is made at the ends of the bearings to collect all the oil which may escape and return it to the cellars to prevent a drip on the structure and the street beneath. The bearings are made exceedingly long and the shafts are large in diameter, the pressure per square inch being reduced to the very low value of 37 pounds. The armature bearings are solid and are lifted out of the motor together with their oil cellars when the armature is removed by an overhead crane.

The gear housing is made of heavy cast iron in halves, the lower half being permanently fastened to the motor frame, while the upper half may be lifted off independently by the overhead crane. The housing is grease-tight and the gears run in oil. The entire motor is cast from the best quality of steel.

The motors are controlled by a series parallel controller, which provides for keeping a constant current through each of the motors of such a quantity as will just avoid slipping the wheels during the time of acceleration. We have named this the "maximum constant current acceleration controller." In order to accomplish this kind of a control, the counter electromotive force of the motors is prevented from rising until the train has reached the maximum speed at which it is desired to operate it. The counter e. m. f. is then instantly raised to a point which reduces the current to a quantity which produces a horizontal effort sufficient to overcome the resistance of the train and maintain a constant speed.

The accompanying diagram (Fig. 4) shows the acceleration curve of an ordinary series parallel controller and two series motors; also a curve of the constant current method of control, with two motors of the same size. The advantages of this latter method are apparent in the decrease of the schedule time and the decrease of power consumption.

The Brakes.

Westinghouse air-brakes are used on all trains, with a brake applied to every wheel, enabling a train to be brought to a stop with a negative acceleration of 3 feet per second, which is not disagreeable to passengers.

The train-pipe for this system of brakes is fed with air from a main reservoir attached to one side of the truck bolster of the idle truck of the motor car. On the other side of the truck bolster is attached an electric-motor air-compressor. The motor is arranged to automatically stop and start under the influence of the varying pressure in the main reservoir. The object of putting the air-compressing apparatus on the truck instead of on the car body is to avoid the disagreeable noise due to the operation of the pump and to facilitate repairs, as the truck with its entire air-compressing outfit is run out from under the car in the same manner as the motor truck.

Third Rail Feeder System.

A third rail varying section should be mounted throughout the entire length of the road on substantial insulators. Heavy rails should be laid near the station, and gradually taper off to the end of the road. For most "L" roads, it is not necessary to use auxiliary feeders of any kind as the entire power necessary to operate all trains can be carried by the third rail. This rail should be placed

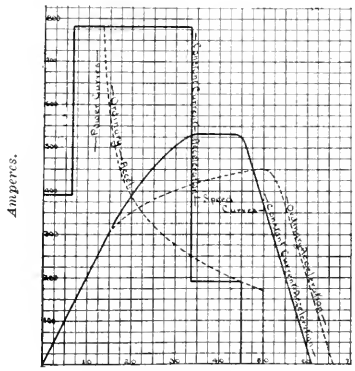


Fig. 4.

on one side of the track with its head some inches above the track rails, so that sliding shoes made of cast iron and attached to the trucks may slide freely along their upper surface.

Bonding.

All rails, as far as practicable, should be in 60 foot lengths. The third rail, as well as the track rail, joints should be bonded by a flexible copper bond attached to the under side or the foot of the rail by means of a number of rivets, and the area of contact with the rail should be sufficient to provide that no more than 100 amperes per square inch should be required to pass through the joint between the steel and copper.

The sectional area of the bond must be one-sixth the sectional area of the rail itself.

The track rails should be electrically connected frequently with the elevated structure.

Care should be taken that all joints between copper and steel should be made with clear, bright surfaces, and no space be left to admit water or air to corrode the joints.

EQUIPMENT AND MANUFACTURING NOTES.

Trojan couplers will be placed on 500 box cars now building for the Canada Atlantic by the Pullman Palace Car Company.

The Elliot Car Company, of Gadsden, Ala., has received an order for 450 box cars from the Louisville & Nashville.

The Michigan-Peninsular Car Company, of Detroit, has secured an order for 50 refrigerator cars for Swift & Company.

National Hollow Breakbeams are used on the three Brooks locomotives for the Adirondack & St. Lawrence Railway.

The Erie has given an order for 500 box cars to the Michigan Peninsular Car Company.

The Mt. Vernon Car Manufacturing Company has taken an order for 250 box cars from the Georgia Railroad Company.

The Ohio Falls Car Manufacturing Company, of Jeffersonville, Ind., has an order for 10 passenger cars for the New York, Ontario & Western

The Ensign Manufacturing Company, of Huntington, W. Va., has received orders for three Russell snowplows from the Long Island Railroad and for 55 refrigerator cars from the Southern Pacific.

Jackson & Sharp have received an order for 25 passenger cars from the Waterloo underground railroad of London. They will be of the American type.

The Railroad Supply Company, of Chicago, has taken up the manufacture of the Barr vestibule, formerly made by the Drexel Manufacturing Company.

The Ohio Falls Car Manufacturing Company, of Jeffersonville, Ind., has received an order to build 100 flat cars for the Mobile, Jackson & Kansas City Railroad.

The Schoen Pressed Steel Company is doubling the capacity of its plant by the erection of three steel buildings which will be equipped with the most improved machinery, both electric and hydraulic.

A train of the Goodwin Car Company's new steel gravity dumping cars is in daily use handling rock and earth in the work on the Jerome Park reservoir on the New York & Harlem Railroad. The cars may be seen and examined by persons interested.

The Missouri Pacific Railway has given an order for 500 freight cars to the Missouri Car Foundry Company. These builders have also received an order for 200 cars from the Texas & Pacific, and one for 200 from the International and Great Northern.

The St. Louis flush car door will be furnished by the Western Railway Equipment Company of St. Louis, Mo., for the 300 freight cars recently ordered by the Texas & Pacific. These doors will also be applied to 150 cars now building for the International & Great Northern by the Mt. Vernon Car Company.

The Pintsch light has been adopted by the Mobile & Ohio for the illumination of its cars and a gas plant is being erected on railroad property at Mobile, Ala. Pipe lines will be run to the Union Station, and also to the government wharf, in order to supply gas to the Pintsch buoys in Mobile Bay.

The Nassau Electric Railroad, of Brooklyn, N. Y., has contracted with the Standard Railroad Signal Company for three interlocking-plants with a total of 38 levers.

It appears probable that the Hudson River Tunnel scheme will be revived. Mr. C. M. Jacobs is now engaged in working up the financial end of the project in London.

The National Switch and Signal Company. Easton, Pa., has closed a contract for an interlocking plant at Earlville, Ill., at the crossing of the C., B. & Q. and C. & N. W., with 18 working levers and electric locking for the derailing switches.

Detroit lubricators will be used on the two locomotives for the Wiggins Ferry Company, which are being built by the Baldwin Locomotive Works.

The Baldwin Locomotive Works will build 10 compound freight engines for the Canadian Pacific Railway and two six-wheel switching engines for the Wiggins Ferry Company, of St. Louis.

The Leach sander is used on the three locomotives which have been built by the Brooks Locomotive Works for the Adirondack & St. Lawrence Railway.

The Ashton Valve Company is furnishing the safety valves and steam gages for the 10 mogul engines which are being built for the Illinois Central by the Brooks Locomotive Works.

The valves for the ten 19 by 26-inch mogul locomotives now building by the Brooks Locomotive Works for the Illinois Central Railroad, as noted in our issue of last month, are of the American Balance type, and are being furnished by the American Balance Valve Company, of Jersey Shore, Pa.

The Baldwin Locomotive Works will build two passenger and four freight engines of the Vauclain compound type for the Chicago, Milwaukee & St. Paul. The same firm has received an order from the Imperial Government Railways of Japan for 20 mogul locomotives with 48 inch driving wheels and tenders of 2,600 gallons capacity, to haul a load of 336,000 pounds up a grade of 1 in 40, combined with 15 chain curves at a speed of 18 miles per hour. The engines are to have automatic vacuum brakes, copper fireboxes and brass flues.

The New Orleans & Western is stated to be about to build shops and a roundhouse at Port Chalmette, La.

It is announced, though unofficially, that the Philadelphia & Reading Railway Company has purchased the plant of the Whitney Car Wheel Works, Philadelphia, with a view to equipping their entire road with car wheels direct from that plant.

The A. A. Griffing Iron Company, 66 Centre street, New York, is advertising its heaters with large colored posters showing the interior of the Bundy Sectional Tubular Heater. These cannot fail to attract attention to the product of the company.

All the shops of the entire Burlington system began working 10 hours on July 26, and the Atchison, Topeka & Santa Fe is now working 1,525 men 55 hours per week on car repairs to handle the the wheat crop. For the first time in four years full time is being worked at the Iron Mountain Railroad shops at Desota, Mo.

The Long & Alstatter Company, of Hamilton, O., has just finished a large punching and shearing machine for the Missouri Pacific shops at Baring Cross, Ark. The machine is an extra heavy double punch and shear, with 42-inch throats, and is capable of punching a 2-inch hole through $1\frac{1}{4}$ inches of metal. Its reach is sufficient for a 42-inch sheet.

It is announced that a deal is nearly concluded between the American Air Power Company, of 160 Broadway, New York, the owners of the Hardie system of compressed-air traction, and the Metropolitan Traction Company, of New York, who control the Hoadley patents. Under the terms of the agreement a new company will be organized to control both the Hardie and Hoadley systems, and the Metropolitan Traction Company will at once order about 50 Hardie motors for use on the company's cross-town lines.

General Superintendent Chasseaud, of the American Institute Fair to be held in New York City from Sept. 20 until Nov. 4, is now busily engaged in his office receiving applications for space from intending exhibitors and dealing with the details necessary to the organization of an extensive exposition. Mr. Chasseaud is planning to amplify the departments that have throughout the annual fairs of the American Institute been regular features, and will inaugurate several new departures.

The wisdom displayed by Receiver Oscar G. Murray, of the B. & O., by making a traffic alliance with the Great Northern Steamship Company through Fairport, and the handling of Chicago and Milwaukee freight by way of the Owen Line of steamers, has been demonstrated by material results. Up to July 1 the westbound package freight receipts at Fairport increased about 8,000 tons and eastbound increased about 3,000 tons. The total increase of business was about 25 per cent.

The cities of New York and Boston are trying to keep abreast of the times in the matter of mail transportation and are hurrying forward the completion of the pneumatic tube conduits that form part of the Batcheller rapid postal despatch system, which has been adopted. To operate the system New York is to have two compressors with steam cylinders of 13 inches diameter and air cylinders 26 inches diameter by 20 inches stroke; and one compressor with cylinders 10 inches and 24 inches diameter, respectively steam and air, by 20 inches stroke. Boston is to have two air compressors of the latter size. All five compressors are to be "duplex" and the Rand Drill Company, of 100 Broadway, New York, has the contract for making them.

According to the New York *Sun* President A. J. Moxham of the Johnson Steel Company, who is now in England, has just received orders for 20,000 tons of steel rails for electric roads in Ireland. This is probably the largest order of steel rails for electric railway purposes ever shipped out of this country, and the fact that they are sent to the very doors of England is one of the notable features of the affair. The same journal says that Japan is about to place a contract in America for the rails and material required for the 1,200 miles of railroad which it is to construct in Formosa.

The Pittsburgh *Post* says: "The present Baltimore & Ohio management ought to be proud of the record made at Chicago, where it is openly admitted that the new Royal Blue Line trains are the finest that enter the Grand Central depot. Since the repainting and remodeling of the rolling stock the Baltimore & Ohio has earned quite a reputation for fine looking passenger trains, but when the people at the Grand Central at Chicago openly admit that the Baltimore & Ohio has the finest trains entering the building the managers ought to be elated."

A proposition to fit one of the battleships of the *Idiana* class with pneumatic apparatus for steering, turning the turrets, refrigerating, and other purposes, according to the New York *Sun*, is being considered by the Navy Department. Pneumatic arrangements have been on trial on the monitor *Terror* for some time, and it is clear that if the designs of the machinery are well carried out, the second trial will be as successful as the first, and the pneumatic engineers will doubtless see to it that the opportunity for extending the usefulness of compressed air is not lost.

The Sargent Company, Old Colony Building, Chicago, has recently cast a large portable riveter frame in open-hearth steel at the Chicago works. The weight of the casting is 1,000 pounds and the gap of the riveter is 69 inches. It was made for the Chicago Bridge and Iron Works for the pneumatic machine that is to be used in the construction of the bridges for the track elevation work on the Chicago, Rock Island & Pacific Railway in Chicago, and the gap is sufficient to handle any of the plates used. The casting itself is said to be a remarkably good and perfect one, and this is borne out by an excellent photograph which we have received.

Within a short time the long talked f pneumatic despatch system between the New York and Brooklyn post offices will be an accomplished fact. The tubes for conveying postal matter from one city to the other are now being laid. The line will extend from the New York Post Office up Park Row and over the Brooklyn Bridge to the Brooklyn Post Office. The Ingersoll-Sergeant Drill Company, of New York, is furnishing the air compressors to supply pneumatic power for the purpose, and already has orders for several compressors. They will also supply compressors for the plant being installed in Philadelphia. The Batcheller despatch apparatus is the system employed and it will probably be extended throughout all of the cities named.

The Q & C Company has issued the following circular: "We desire to give notice that the exclusive manufacture and sale of the tie plate known as the C. A. C. plate, which is now made in its improved form, is now in our hands, and all quotations and inquiries should be addressed to us. . . . Our company is recognized as having introduced into successful use the plate well known as the Servis tie plate. We have been strong advocates of the longitudinal form of plate with flanges on the outer edge of plate, and the 12 years' success of same, and the many millions in use, distributed over most of our large railroad lines, are facts which prove the justification of our claims. . . . While we cannot consistently advocate forms of plates which differ from the Servis, still to those who insist upon making personal trial, or who specifically demand plates having upper shoulders and crosscutting flanges on under surface of same, we offer the C. A. C. plate, as now improved, as being the most perfect and effective form of that kind."

The Schenectady Locomotive Works are erecting a new riveting tower in their boiler shop and putting in two new hydraulic riveters of 75 and 100 tons capacity each. One of the riveters has a gap of 17 feet, while the other has a gap of 12 feet. The riveters are being built by R. D. Wood & Company, of Philadelphia. Each of the riveters will be supplied with a 20-ton electric crane, furnished by William Sellers & Company, of Philadelphia, the motions of which, hoisting, racking and traversing, are performed by electric motors, operated by the man standing on the riveter platform and who operates the riveter.

is probable that very few people have any idea of the number of different kinds of merchandise an ocean steamship carries from the United States to foreign ports. A short time ago the Johnson Line steamer *Vedamore* loaded at the Locust Point docks of the B. & O. at Baltimore 66 cars of lumber, 4 of starch, 19 of oil cake, 6 of provisions, 1 of organs, 1 of flour, 22 of tobacco, 2 of wire, 3 of sugar, 13 of fresh meat, 20 of sheep, or 1,699 head; 15 of cattle, or 888 head; 3 of lead, 1 of copper, 4 of merchandise and 161 of grain, making a total of 371 carloads.

Our Directory

OF OFFICIAL CHANGES IN AUGUST.

Chattanooga Southern.—W. S. Hoskins has been appointed General Manager, vice M. F. Bonzano, resigned.

Chicago, Peoria & St. Louis.—Mr. H. T. Porter has been appointed Chief Engineer, and Mr. H. C. Landon has resigned to accept a similar position with the New York & Ottawa, headquarters at Cornwall, Ont.

Chicago, Iowa & Dakota.—Mr. Conrad Miller has been elected President.

Chicago Terminal Transfer Railroad Company. — Mr. S. R. Ainslie has been appointed President and General Manager.

Cleveland, Cincinnati, Chicago & St. Louis.—Mr. Geo S. McKee has resigned as Master Mechanic to take a similar position on the the Wabash at Moberly, Mo.

Colorado & Northwestern.—Mr. J. T. Blair has been chosen General Manager of this new line, which will start from Boulder, Colo., and run to Salt Lake City.

Columbus, Sandusky & Hocking.—Mr. F. P. Boatman has been appointed Master Mechanic at Columbus, O.

Delaware, Susquehanna & Schuylkill.—Mr. Irving A. Stearns has been elected President.

Dominion Atlantic.—Mr. M. Stewart has been appointed Chief Engineer with headquarters at Kentville, N. S., vice Mr. K. Sutherland, resigned.

Duluth, Missabe & Northern.—Mr. William J. Olcott has been elected Vice-President in place of John T. McBride, resigned.

Fitchburg.—Mr. Henry S. Marcy, President, died Aug. 10, and will be succeeded temporarily by Mr. Robert Codman, a member of the executive committee.

Flint & Pere Marquette.—Mr. John W. Graham, President of the International Trust Company, of Boston, has been elected Vice-President.

Fonda, Johnstown & Gloversville.—Mr. J. Leslie Hees has been chosen President.

Fort Wayne, Terre Haute & Southwestern.—Mr. F. L. Winsor has been appointed Receiver, with office at Geneseo, Ill.

Grand Trunk.—Mr. S. King has been appointed Master Car Builder in charge of shops at London, Ont.

Green Bay & Western.—Mr. J. A. Jordan, Vice-President of this company, has been also appointed General Manager and Purchasing Agent, vice S. W. Champion, resigned.

Illinois Central.—Mr. David Sloan has been appointed Chief Engineer.

Kansas Midland.—Mr. C. A. De Haven has been appointed Master Mechanic at Wichita, Kan.

Lake Shore & Michigan Southern.—Mr. S. R. Callaway, formerly President of the New York, Chicago & St. Louis, has been elected President to succeed the late D. W. Caldwell.

Mexican International.—General Thomas H. Hubbard has been elected President of this company.

Norfolk & Western.—Mr. L. E. Johnson has been appointed General Superintendent, with headquarters at Roanoke, Va. He was formerly Division Superintendent of the Lake Shore & Michigan Southern Railway.

Northern Pacific.—Mr. C. S. Mellen has been elected President. He was formerly Second Vice-President of the New York, New Haven & Hartford.

Northern Ohio.—Mr. David Anderson has been appointed Master Mechanic, with headquarters at Delphos, O.

Omaha, Kansas City & Eastern.—Mr. John M. Savin has been appointed General Manager. Th s road is the consolidation of the Omaha & St. Louis and the Quincy, Omaha & Kansas City.

San Antonio & Gulf Shore.—Mr. Jesse Frey has been appointed General Manager, vice Mr. Geo. Dullnig, resigned.

Sylvania.—Mr. L. H. Hilton, of Sylvania, Ga., has been elected President.

Sherman, Shreveport & Southern.—Mr. Thomas H. King, Vice-President of this company, was drowned while bathing on June 16. The position of Vice-President will remain vacant for the present.

South Atlantic & Ohio.—Mr. Channing M. Ward has been appointed General Manager.

Southern Pacific.—Col. Chas. F. Crocker, First Vice-President, died at San Mateo, Cal., July 17.

Texas, Sabine Valley & Northwestern.—Mr. G. M. D. Grigsby has been elected President and General Manager.

Vancouver, Klickitat & Yakima.—Mr. Samuel F. Canby, Manager, was drowned July 26.

Wilkes-Barre & Northern.—Mr. David T. Bound has been appointed General Superintendent and Purchasing Agent.

Wiscasset & Quebec.—Mr. A. S. Erskine has been appointed Master Mechanic, with headquarters at Wiscasset, Me.

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

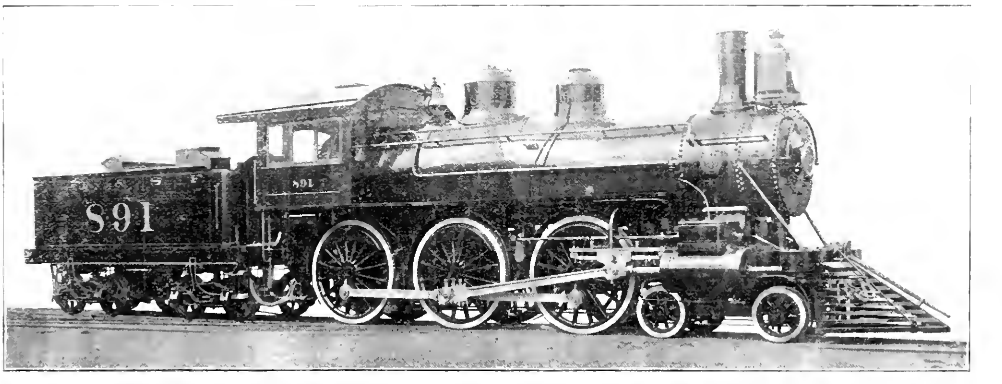
OCTOBER, 1897.

CONTENTS.

Ten-Wheel Passenger Locomotive – A., T., & S. F. Railway.

By The Dickson Manufacturing Company.

Through the courtesy of Mr. John Player, Superintendent of Machinery of the Atchison, Topeka & Santa Fe Railway, and of The Dickson Manufacturing Company, we are enabled to show our readers some of the chief features of the design of 10-wheel passenger locomotives, of which eight are now being built for that road.



Ten-Wheel Locomotive–Atchison, Topeka & Santa Fe Railway.

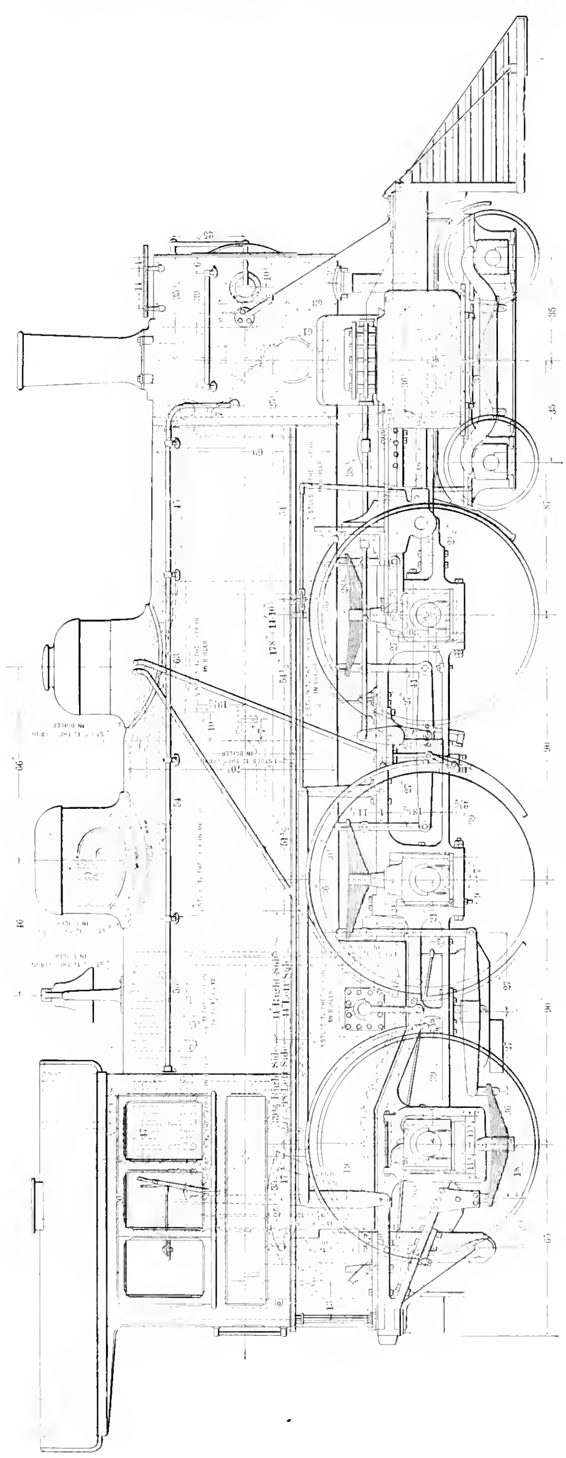
The design was prepared by Mr. Player, and from the excellent reports received from the new freight engines built by the road at Topeka, it is fair to expect that the passenger engines will be very satisfactory. The officers of this road believe in large heating surface with a moderate size of grate, the ratio between the heating surface and the grate area being 86 to 1, which is unusually large. It is interesting to note that the corresponding ratio for the 10-wheel passenger compounds for the Northern Pacific, described in our June number, is 81 to 1, and that for the Monon 8-wheel passenger engine, shown in our August number, is 70 to 1. It is clear that the tendency toward larger heating surfaces is growing. A ratio of 106 to 1 is now in use, and while that may be considered as far in advance of usual practice, there is a tendency to follow these examples. There also seems to be a tendency toward the use of rather smaller grates, although this is not at all likely to be carried to an extreme.

The engine under discussion is of the extended wagon-top type, with the Player patent combination crown bar and stay-bolt type of crown-sheet staying. The frames are forged down and the firebox is above them, the grate being part horizontal and part sloping, as shown in the large engraving. The firebox is 88 inches long by 42 inches wide, a good comfortable size for the fireman to cover well. The engine has a grate of the rocking type, a brick arch supported on water tubes: it has a short deck with diagonal braces from the frames to the back boiler-head. The air pump is placed under the cab, back of the engineman's seat.

The driving wheels are 73 inches in diameter and the cylinders are $19\frac{1}{4}$ by 28 inches. The steam pressure will be 180 pounds per square inch, and it is evident that with the combination of these parts the large boiler will be found very useful on hard pulls. The weight on drivers is 110,000 pounds, or 18,300 pounds on each driver; the total weight is 143,000 pounds, which is lighter than the Northern Pacific engines referred to, weighing 155,500 pounds.

Among the other noteworthy features of the engine are the use of the Rushforth feed-water heater, the Houston sander, the large capacity of the tender tanks, 4,650 gallons, the Laird guide, long, guided valve rods, extended piston rods and underhung springs for the rear driving axle. The equalizing is on a combination plan and its details are shown clearly in the engraving. The tender tank is unusually large and the frame of the tender is of steel. The following table presents the principal dimensions of the engine:

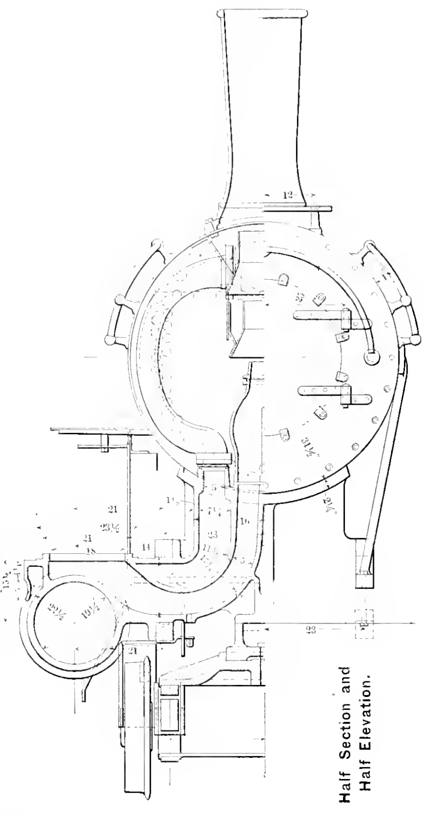
Fuel.	Bituminous coal.
Weight on drivers	110,000 pounds
" truck	30,000 "
Total weight	140,000 "
Wheel base, rigid	15 feet
" " total	25 feet 2 inches
Length in all, engine and tender	55 feet
Boiler, type	extended wagon-top
Working pressure	180 pounds
Diameter barrel, smallest ring	60 inches outside
Thickness of material in boiler	$\frac{1}{2}$-inch, 9 16-inch and $\frac{5}{8}$-inch
Seams, horizontal	quadruple butt joint
" circumferential	double
Dome, diameter	30 inches
Firebox, length	88 inches
" width	42 "
" depth, front	$64\frac{1}{2}$ "
" " back	58 "
"	brick arch on tubes
Thickness tube sheet	$\frac{1}{2}$ inch front, [illegible] inch back
" side and back sheet	$\frac{3}{8}$ inch
" crown sheet	$\frac{1}{2}$ inch
Crown sheet stayed with Player crown bar and stay.	
Grate bar	cast-iron shaking
Tubes, number	264
" diameter	2 inches
" length	14 feet 10 inches
" gauge	No. 11 W. G.
Heating surface, tubes	2049.5 square feet



TEN-WHEEL LOCOMOTIVE—ATCHISON, TOPEKA & SANTA FE RAILWAY.

JOHN PLAYER, *Superintendent of Machinery.* DICKSON MANUFACTURING CO., SCRANTON, PA., *Builders*; C. H. ZEHNDER, *President.*

Heating surface firebox	146.5 " "
" " total	2,96 0 " "
Grate area	25.5 " "
Cylinder, diameter	19½ inches
Piston stroke	28 "
" rod, diameter	3¼ "
" " packing	Jerome metallic
Valve	Richardson Balanced
Driving wheel, diameter	73 inches
Truck " "	30 "
Journal driving axles, size	8½ inches dia., 10 inches long
" truck " "	5½ inches dia., 10 inches long
Main crank pin.	6 inches dia., 6 inches long; 6¼ inches dia., 5 inches long.
Back and front crank pin	5½ inches dia., 3¾ inches long
Smokebox, diameter	63 inches
" " length	61 "
" stack, smallest diameter	14½ "
Exhaust nozzle	Single
Sand blast	Houston



Half Section and Half Elevation.

Feed-water heater	Rushforth
Reed cyclone blow-off cock.	
Tender frame	Steel, 9 inches deep
" truck wheel, kind	Standard wrought iron center steel tire
" " " diameter	30 inches
" " axle	4¼ inches dia., 8 inches long
Tank capacity for water	4,650 gallon
Length of tank	19 feet 9 inches
Width of tank	9 feet 1 inch
Height of tank, not including collar	4 feet 8 inches
Material in tank, thickness	¼ inch and $\frac{5}{16}$ inch

A good crop and a place to put it is sure to make railroad business good. We are informed that during a single day in early September over 5,000 car loads of grain were landed in Chicago, and that 37 trains with a total of 1,220 loaded cars of grain were dispatched from Galesburg, Ill., to Chicago in a single night over the Burlington road.

Pintsch Gas Tanks in a Wreck.

On page 316 of this issue, a brief statement is made with regard to the alleged explosion of Pintsch gas tanks in the wreck which occurred on the Rio Grande Junction Railroad, September 10. It was stated that an explosion of a gas tank under one of the cars caused the fire which added to the horrors of the disaster. No one who gives the subject thoughtful attention will consider such a claim, but in order to show that this is not a mere matter of opinion in this case we publish in full a report, received since the above-mentioned paragraph was written, upon the condition of the gas tanks based upon an examination that was made after the wreck. This is signed by Mr. C. H. Quereau, a disinterested person, as well as by Mr. Schlacks and Mr. Hooper. The names of Mr. Schlacks and Mr. Quereau used in this connection will satisfy all who know them. There is evidence to show that some sort of an explosion occurred after the wreck, but that the gas tank did not explode is established by this report, which we reproduce verbatim as follows:

DENVER, COL., Sept. 20, 1897.

To the Denver & Rio Grande Railroad Co., Denver, Col.:

GENTLEMEN: We were this day requested to examine the tanks that were loaded on D. & R. G. coal car No. 15,214, being shipped in this car from the place of accident to Denver, and are, as we understand, the Pintsch gas tanks removed from the recent wreck at New Castle.

We saw these tanks unloaded and brought to a platform near your storehouse at Burnham, and the nine tanks were marked from one to nine, also the date 9|20 and the number of the car 15,214 being marked on with paint on the ends of these tanks.

Tank No. 1. Heads good; body badly bent; all rivets intact.

Tank No. 2. This tank is not dented and rivets all in place.

Tank No. 3. Both heads good; body slightly dented; rivets in place.

Tank No. 4. Both heads good; body dented very little and rivets good.

Tank No. 5. One head slightly dented and one good the body dented badly; rivets all in place.

Tank No. 6. Nearly perfect; some slight dents in body and three screw-bolt heads knocked off; apparently knocked off after fire.

Tank No. 7. Nearly perfect, with the exception of one bolt head on one of the heads broken off; apparently done before the fire.

Tank No. 8. Very badly dented and bent; one of the heads dented and small hole ½ inch long by $\frac{1}{32}$ inch wide knocked in it; rivets and bolts all in place; one head good.

Tank No. 9. Badly bent and out of shape in middle; heads good; all rivets in place and seem to be good; no indication either on body or heads of a rupture.

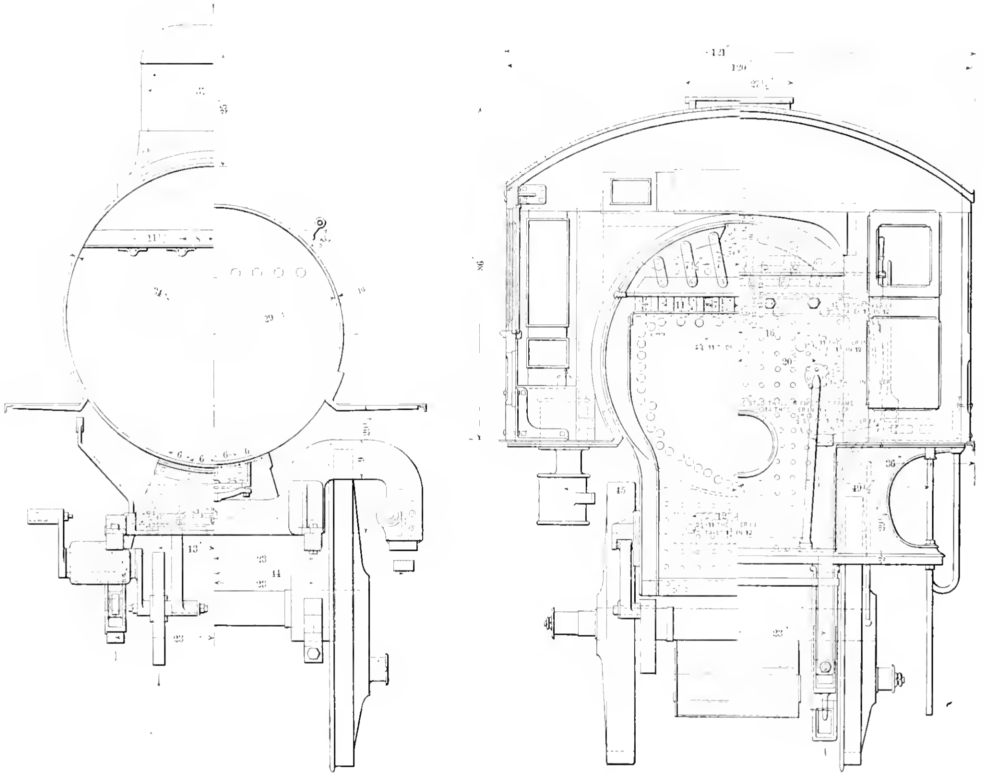
All these tanks had the appearance of going through the fire, and were more or less bent, dented and burnt; and on account of the excessive heat, the solder in the joints was melted out and they were more or less warped; but on none of these tanks, no matter how hot they seem to have been, or whatever strain they were subjected to, on account of parts falling on them, there is not the slightest indication of an explosion; and we can state without hesitation that these tanks were not exploded at the wreck or anywhere else; and from all appearances, they were in first-class condition before the accident.

They are the tanks furnished by the Pintsch Gas Company, and the mechanism of these tanks is first-class.

(Signed) Henry Schlacks,
Superintendent Machinery.

W. H. Hooper,
Representative Pintsch Gas Company.

C. H. Quereau,
General Foreman, B. & M. R. R. R.



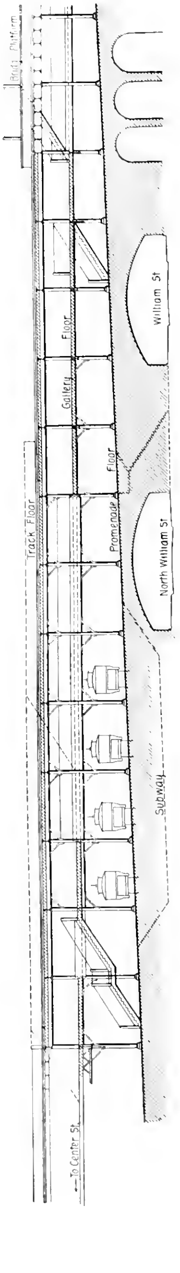
Ten-Wheel Locomotive—Atchison, Topeka & Santa Fe Railway.

Information recently received from Tokio, Japan, indicates that the Japanese government have finally adopted for the 180 miles extension of the Imperial Railway, for which contracts are about to be awarded, the 60-pound section rails, known in America as the Pennsylvania Railroad standard. This action on the part of the Japanese government should be to the advantage of the American mills, as the English sectional standard previously employed requires special rolls and additional handling of rolls. The choice was made, it is said, after close expert comparison with the English standard and with all the standards in use on the principal railways in the United States.

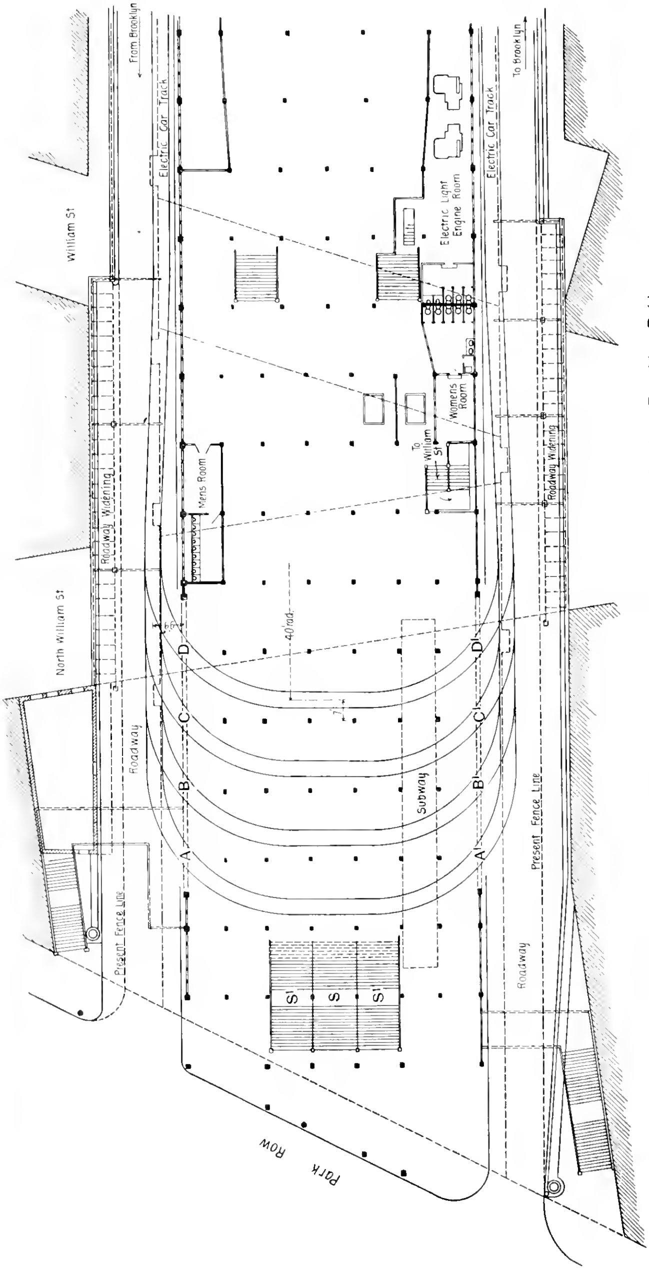
Electric Cars and Elevated Trains on the Brooklyn Bridge.

The admission of the electric cars and elevated trains from Brooklyn over the Brooklyn Bridge, the contracts for which were signed recently, will necessitate a rearrangement of the tracks at the New York terminus and somewhat of a change at Brooklyn for the connection of the rails of the street lines. It was originally intended to provide for the electric cars at the New York end of the bridge by means of an additional deck, to be erected over the present platform. This idea, however, has been abandoned for a much more simple one.

At the Brooklyn end cars will come upon the bridge over Washington street, and in leaving the structure they will cross the Plaza to Liberty street, and this will not require much difficult work, if the present plans are carried out. The changes at the New York terminal are more extensive and our engravings



Longitudinal Section Through Terminal.



Plan View of Proposed Rearrangement of Tracks at New York Station, Brooklyn Bridge.

show in a general way how the new arrangement will be accomplished. The electric cars will come in from Brooklyn over the track shown at the upper side of the plan view and passing around one of the four tracks of the loop will come upon the return track ready for passing over the bridge again. In order to lay these tracks portions of the present brick wall will be removed, as shown by the dotted lines. A plan has been formulated for the operation of the tracks, and if carried out four cars will stop on the curves at the entrance of the loop, one car being on the curve approach to each cross-connection. They will unload here and simultaneously move across the loop tracks, at the other ends of which they will load and will pass out successively for the return journey over the bridge. A subway is provided so that passengers need not cross the loop tracks in taking or leaving cars. The location of this may be seen in the drawings.

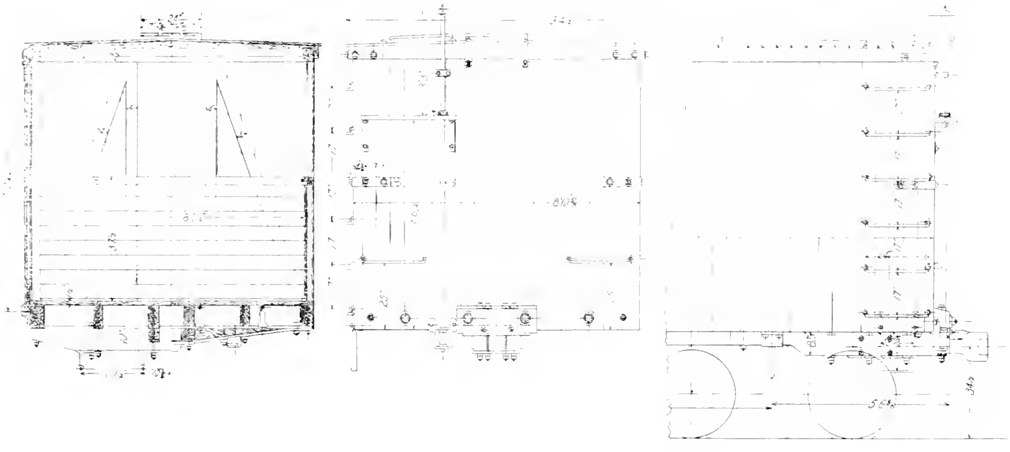
It has been decided to place the trolley cars in the roadway of the bridge on each side of the present bridge car tracks. The location of the new tracks was an interesting problem, and it is believed that this will give the best distribution of loads upon the supporting cables. The effect of the changes of the method of operating the bridge will doubtless be to greatly increase its capacity, and after this plan is put into effect it is difficult to see how provisions for further increase of traffic can be made. It is the intention to continue the present bridge trains, but it seems questionable whether the trolley cars will not deprive them of a large part of their present business.

Box Cars Without Carlines—Chesapeake & Ohio Railway.

In reply to a number of inquiries concerning the method of construction of box cars without carlines, designed and built by Mr. W. S. Morris, Superintendent of Motive Power of the Chesapeake & Ohio, we present the accompanying illustration taken from a drawing kindly furnished by Mr. Morris.

This design is for cars of 60,000 pounds capacity, their peculiarity being a construction of the roof wherein carlin sheathing takes the place of the usual carlines. The object is to give greater cubical capacity to the car. The plan was first used in building furnishing cars and gave 250 cubic feet of additional space available for loading without any change in the outside dimensions of the car. There are now about 400 of these cars in use, some of which have been in service for more than five years, and Mr. Morris states that they have given very satisfactory results and no failures of the roofs have been reported.

The method of constructing the roof and its appearance outside and inside will be understood from the engraving. The carline sheathing is 6 inches wide. It is tongued and grooved and is 1 inch thick at the ends and 2¼ inches thick at the center. The sheathing is separated from the roof boards by roof felting, as shown in the drawing.



Box Cars Without Carlines—Chesapeake & Ohio Railway.

Opening for American Enterprise in China.

Consul Read, of Tientsin, has transmitted the following letter to the State Department from Messrs. Taylor & Company, of Tientsin, China:

China, in the next few years, will be a buyer for all classes of machinery, and especially railway materials. It has been demonstrated that America has chances as good as those of any other country to secure orders.

If our American manufacturers will make the proper efforts it will result in millions of dollars of trade.

A commercial representative should be selected, care being taken that he has influence in the proper quarters, which, as you know, is absolutely essential. This representative should be the sole agent in the East. He should be authorized in the proper form, as are the representatives of European houses, with the seal of the foreign office; and his name should be registered here in the consulates.

In the construction of a railway the Chinese require rails, sleepers, couplers and structural iron for bridges and locomotives. If the best houses in America will place their respective business interests in the hands of one good business firm in Tientsin, this firm can bid for everything wanted, will appear strong in the eyes of the Chinese, and each transaction will, perforce, strengthen the mutual business relations between America and China.

If we may be allowed to do so, we would advise that you lay all we have to say before the officials of the Department of State at Washington, with the suggestion that they call the attention of our manufacturers of railway materials, including the Westinghouse Air Brake and Wharton Switch companies, and manufacturers of firearms, locomotives and men-of-war to the existing opportunities for doing business in this section of the world.

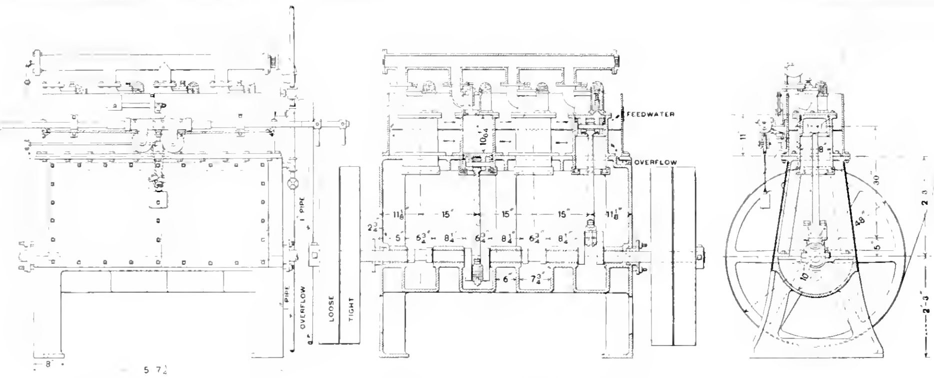
We have information that the Chinese Emperor has issued an imperial edict authorizing the purchase of six first-class battle ships, six first-class cruisers, six second-class cruisers, and twelve torpedo boats. The Chinese Government is going to create a loan of 100,000,000 taels, a part of which will go toward purchasing the vessels.

His Excellency Li Hung Chang (who is now at the head of the Tsung-li-Yamen), in recognition of the assistance of America in bringing about peace in China's war with Japan, is anxious to do something for America, and if there is half a chance we can secure a large share of this business, for that reason.

There will be an enormous trade done here within the next few years, and if America can gain her part, it will mean additional labor to thousands of our workingmen and the bringing to our country large returns in profits to manufacturers.

Unfortunately, America has suffered by the class known as adventurers and fortune-hunters, who have no visible means of existence and who come to China willing and anxious to advance or accept any visionary scheme that offers the least prospect of success—schemes that no business man would have anything to do with, and each failure sets American interests further in the rear.

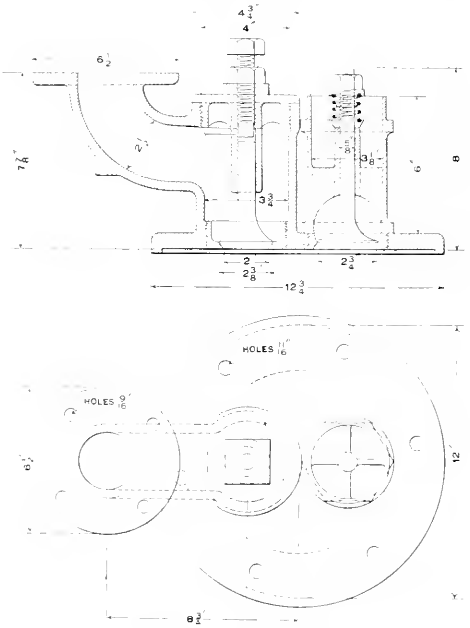
Mr. Read speaks of the presence in China of Mr. C. D. Jameson, representing the Baldwin Locomotive Works, of Philadelphia. It seems that Mr. Jameson made a contract with the Chinese government for four locomotives to be delivered at Tangku on or before June 30, 1897; also, for eight locomotives to be delivered between July 20 and Sept. 20, 1897.



Belt-Driven Air Compressor—Chicago & Northwestern Railway.

Belt-Driven Air Compressor, Chicago & Northwestern Railway.

The shops of the Chicago & Northwestern Railway, at West Fortieth street, Chicago, are well equipped with compressed-air appliances, and having found it necessary to add to the compressor plant the belt-driven compressor shown in the accompanying engraving was designed and built at these shops.



Belt-Driven Air Compressor.

The compressor is single-acting and has a crank case for the purpose of running the cranks in oil, after the plan of the Westinghouse engines. The air-admission valves are placed directly on the tops of the cylinders, as will be seen by the engraving. The clearance is small, which is an important point not always considered in air compressors built by non-professionals, and in this particular the design under consideration is worthy of favorable comment. The space between the piston in its uppermost position and the cylinder head is only $\frac{1}{64}$ inch. The construction of the valves may be seen in the sectional view. The inlet and outlet valves for each of the four cylinders are mounted on the cylinder-head castings, and the outlet valves are connected to a cast-iron manifold discharge pipe leading to the storage reservoir.

The cylinders are of cast iron, and by being provided with a flange connection for bolting to the crank case are easily removable. They are surrounded by an open-topped casing in which cooling water circulates, a horizontal diaphragm being provided in order to secure a current of water about the cylinders, as indicated by the arrows in the central view of the large engraving. The stroke of the pistons is 10 inches and the length of each cylinder above the pistons in its lowest position is $10\frac{1}{64}$ inches, which emphasizes what has been said about the clearance. The pistons are $5\frac{1}{2}$ inches deep and are cast with bosses to receive the wrist pins with which the connecting rods connect. Holes are drilled through the pistons for the purpose of inserting the pins. The packing is double, in the form of $\frac{3}{8}$-inch cast-iron rings. For the lubrication of the cylinders annular oil cups are secured to the bottom ends of the cylinders in such a way as to allow the pistons to dip into them at their lowest positions at each stroke.

As shown in the front elevation, the sides of the crank case are removable for the purpose of getting at the cranks and rods, and with a few minutes' work the whole machine may be readily uncovered for repairs. The governor is so arranged that when the pressure at which it is set is reached the belt is shifted from the fast to the loose pulley by means of air pressure admitted to the governor cylinder. When the pressure in the reservoir decreases the air escapes from the governor cylinder and the weight shown in the illustration shifts the weight to the driving pulleys again. The fixed pulleys have heavy rims in order to enable them to act as flywheels. The compressor is nearly 7 feet high, and about 9 feet wide over all, the depth being 48 inches, or the diameter of the flywheels.

This machine was designed for use in the car department shops where the steam power is derived from the burning of refuse such as shavings from the car work. The arrangement is compact, and it admits of easily renewing parts that may become worn in service. We are indebted to Mr. Robert Quayle, Superintendent of Motive Power, for the drawings.

A recent communication from Consul J. C. Monaghan, written at Chemnitz, with regard to Prussia's railroad earnings, states that more than half Prussia's income is derived from the railroads.

An English contemporary states that the corporation of Blackpool has resolved to abandon the underground electric conduit system in favor of the overhead trolley. This was one of the first electric railroads in the United Kingdom. The reason for the change is the high cost of maintenance of the conduit equipment.

The Works of the Peerless Rubber Manufacturing Company—New Durham, New Jersey.

The importance of the industry of manufacturing mechanical rubber goods is a subject with which our readers are thoroughly acquainted, and we feel sure that the following description will be interesting. There has been a great deal of misunderstanding and somewhat of mystery about the manufacture of rubber, and through the courtesy of Mr. C. H. Dale, President of the Peerless Rubber Manufacturing Company, of 16 Warren Street, New York, we are enabled to illustrate and describe the process as practiced at the works of that company, at New Durham, New Jersey, a short distance from New York City.

The basis for all ordinary rubber goods is the sheet of rubber, and when it is necessary to furnish strength to resist tearing, bursting or tension stresses canvas is incorporated in the structure. In Mill No. 3, which is a new equipment, this process may be seen to the best advantage. There are three separate mills, and the other two will be referred to again. Mill No. 3 is the starting point for nearly all of the crude rubber, though the preliminary process may also be carried out in the other mills when necessary. The building is 219 by 35 feet, and has two stories. It is the most modern plant of its kind in the country, and was fitted up regardless of expense, the primary object in view being to put in a plant for the purpose of making the best of rubber goods. The power is derived from a 300 horse-power Watts-Campbell, Corliss 24 by 40 inch engine connected with the main shaft by large spur gears. The engine is at the center of the mill, and a line shaft runs along under the floor to both ends of the building. The mills and calenders are geared direct to this shaft, and no belts are used. The machine work was done by the Farrel Foundry and Machine Company, of Ansonia, Conn., and it was well planned and executed.

At one end of the building the crude rubber as it is received from Para in the form of large lumps of irregular shape is washed in a tank of hot water for the purpose of removing the loose dirt. The washing is completed in a washing grinder, consisting of one smooth and one corrugated roll. The rubber is washed with hot water while in this machine, and here it takes an irregular sheet form about three-quarters of an inch in thickness. It is still porous and rough, and after thoroughly drying in the drying room overhead it is ready for the grinding or "breaking down." This process is carried on in grinding rolls or calenders heated by steam. The rubber is put into a smooth sheet form, and after being sufficiently "worked" it is ready to receive the "compounds" which are used to prepare it for the special purpose intended. The hose material is compounded differently from that used for making packing, each purpose requiring different compounds, which are all minerals, and the secrets and the skill of the trade are chiefly in the selection and proportioning of the ingredients used in this compounding. The ingredients are weighed out and incorporated into the rubber on the mixing grinders.

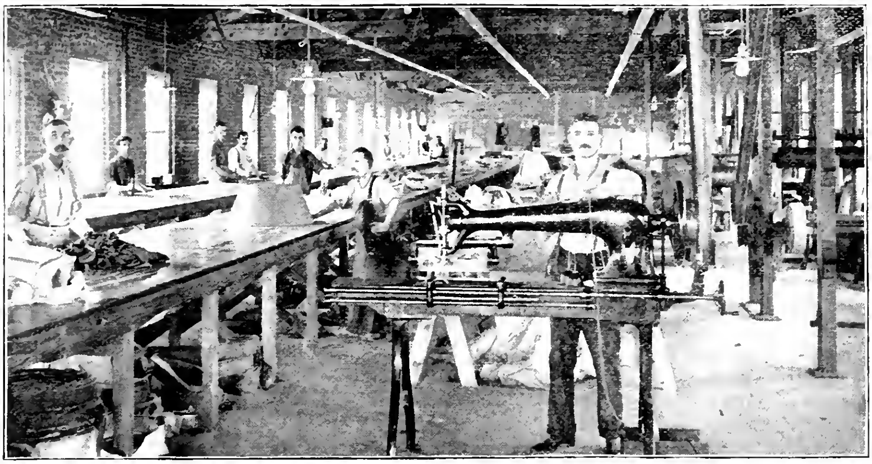
One of our illustrations shows a grinding machine alongside of one of the large calenders. Two horizontal rolls are carried in heavy housings, and the boxes are adjustable for the purpose of putting more or less work, as desired, on the rubber.

After the mixing the rubber is "batched out" on a bench at the rear of the machines, and it is there piled in slabs of irregular shape ready for the next process. That which goes to make packing, gaskets or other similar specialties goes to Mill No. 1. That made for belting or hose is further treated in Mill No. 3 as follows: For belting and hose, duck must be used, and it must be coated and thoroughly impregnated with rubber. This process is carried out on the "friction calender." The rubber used is prepared of the proper thickness on the "sheeter," the three-roll calender shown. These calenders will be referred to again. The sheet is rolled out and is given the proper width by stops, one of which is seen near the left-hand end of the two upper rolls. The duck is prepared in the "friction calender," which differs from the sheeter only in that the middle roll of the friction machine turns one and one-half times as fast as the top and bottom rolls, while the velocity of the three rolls of the sheeter is uniform. The center roll of the friction calender is covered by an envelope of sheet rubber about one-eighth inch thick, and the duck is pressed against the rubber on the hot roll, the difference in the speed of the duck and the rubber causing the rubber to be squeezed entirely through the duck. The friction process is applied to both sides of the duck, and then it may be coated on either side with a sheet of rubber which will readily adhere to the friction duck, and is then ready to be incorporated into a rubber structure al-

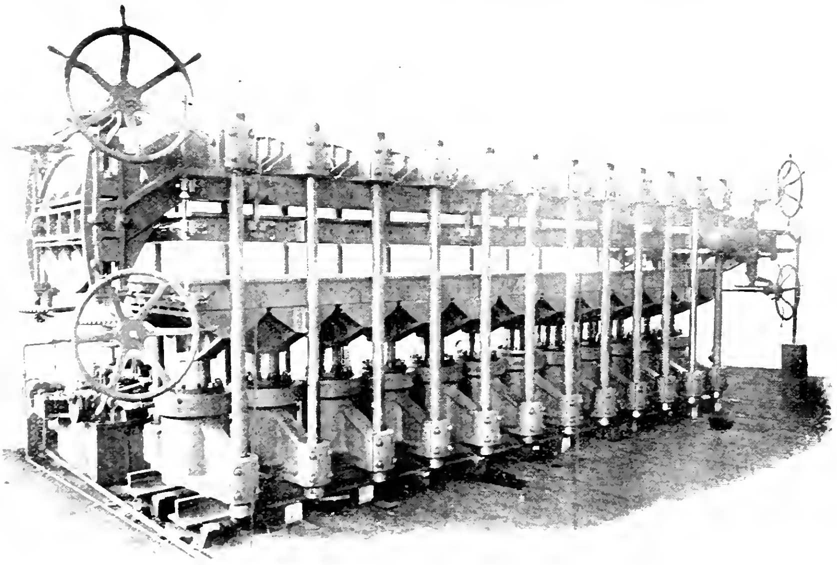
The Hose Department.

most as if it was itself rubber. This friction duck, after receiving a coating of rubber on one side, is the basis of belt and hose making.

In the belt room there are four zinc-topped tables; two of them are 120 feet long each and one is 100 feet long, the fourth being 80 feet long. The belts are laid out here, the friction duck being followed up over a filler strip into the required number of "ply," and the continuous or other kinds of belts that are stitched are put through the large sewing-machine shown in the foreground of the engraving. The stitches are in seams one inch apart. After the completion of the folding of ordinary belts the cover is put on the belt and it is ready for stretching and vulcanizing. Belts 50 inches wide are made in this way. The stretching and vulcanizing are done on a large hydraulic belt press. This press has three plates heated by steam and moved toward each other by 12 hydraulic plungers upon which the bottom plate rests. The stretching is done between the stationary clamp at one end of the machine and the clamp at the other end which is carried by the plungers of two horizontal hydraulic cylinders. The heat of the steam in the plates does the vulcanizing, and when the belts have been stretched and pressed under the action of the high temperature, they are complete and ready for service. In the belt room small belts are made by machinery, which may be seen indistinctly at the right in the view of this room. Here the belts are folded, and completed by passing through rolls. In this way a man and a boy can together make about a mile and a half of 1½-inch belt per day. In this illustration a vacuum brake diaphram is seen in process of making at the left of the sewing-machine.



The Belt Room.



Belt Press Stretcher and Vulcanizer.

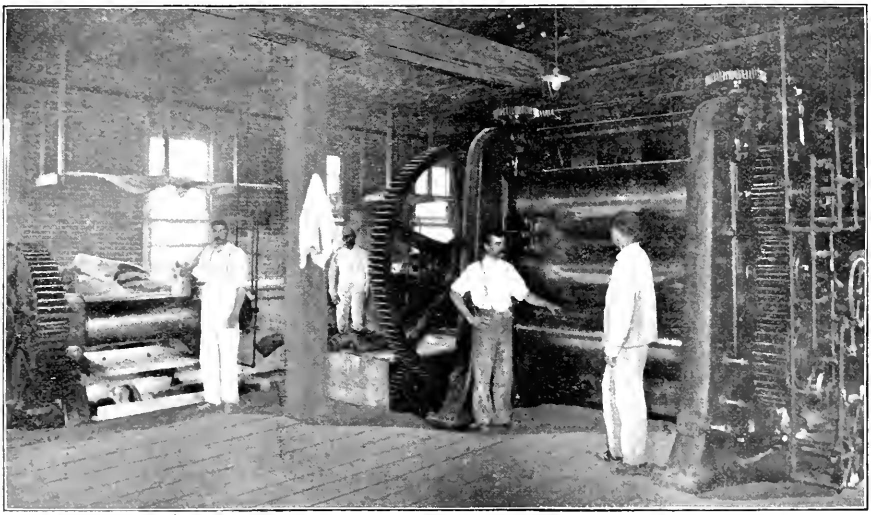
The large calenders and the belt press merit further notice.

They were built by the Farrell Foundry and Machine Company, and are admirable pieces of machinery. It is understood that no limit of cost was placed on them, the builders having carte blanche to build the best possible machines for the purposes.

The large press is a handsome piece of work, as will be seen from the photograph, which was taken at the builders' works. With its foundation it cost $16,000. There are three steam-heated platens for working on two layers of belts at once. The view shows the middle platen supported by links for the purpose of introducing the work. These platens are 50 inches wide by 25 feet long. The 12 hydraulic cylinders are fitted with 10-inch rams with a working stroke of 18 inches. The rams are designed to operate under a pressure of 2,000 pounds per square inch provided by a special geared pump. This pump is seen at the left of the press. It is too slow in operation for moving the plungers when high pressure is not upon them, and an auxiliary Worthington duplex pump is used for moving the platens up to the point where high pressure is to be applied. At each end of the press clamps, already referred to, are provided for stretching the belting. On the front end they are stationary, while those at the rear are carried on the plungers of the two 6-inch hydraulic stretcher cylinders having a stroke of 50 inches. The weight of the machine is 90 tons, its height is nearly 10 feet and its length 34 feet.

line on one side of the engine is 59 feet 2¼ inches and the mixer and washer line on the other side of engine 61 feet 9 inches long. The speed of the main shaft is 65 revolutions per minute.

The hose room is in a one-story building by itself. It is 230 by 42 feet in size and is one of the finest hose rooms in the country. It is unusually well lighted and is a decidedly pleasant shop, as the engraving will show. There are 15 zinc-topped tables, 50 feet long by 45 inches wide, and along the right-hand side are two cylindrical vulcanizers, 3½ by 54 feet in size. Five tables are given to air-brake hose, this being one of the favorite specialties of the company. The duck for the hose, which is made specially for this purpose, is most carefully prepared. As stated, after being put through the friction calender it is passed through the sheeter and receives a coating of rubber on one side of the friction coating. This part of the preparation is important, for the rubber will not stick to the duck, but will stick only to rubber. The friction process must therefore be carried out perfectly or the hose is weak. Much hose is weak because some manufacturers slight this work and depend upon artificial means to stick the friction duck together when it is rolled into the hose. The hose duck is laid out on one of the tables, and, for 1¼-inch hose, is cut into 22 by 22 inch squares, turned so as to be diagonal with the threads of the duck to



Sheeter, Calender and Grinder Rolls.

The grinder rolls are all 16 inches in diameter by 40 inches long on the face, the speed of the driving roll being 22 revolutions per minute. The space occupied by each machine is about 5 by 9 feet. The washer rolls are 15 inches in diameter by 24 inches long.

The large calender machines are not less admirable than the press. The cost of each of them with its foundation was $8,000. The rolls are 22 inches in diameter by 65 inches face, and each machine has two speeds, one of 7 yards and the other of 10 yards per minute. Each calender, including the driving mechanism, takes up a space of 8 by 20 feet, which shows the large size of the machines. The height from the floor to the top of housings is 9 feet 6 inches and the weight about 35 tons. The rolls of the calenders and grinders are all made of chilled cast iron. The frames, bed plates and general parts are of cast iron the roll journals of bronze and all gears of special metal.

The line shaft, already referred to, has a diameter of 6⅝ inches at the engine end, tapering down to 5⅝ inches at the farthest point away from the engine. The total length of line shaft, including engine jack shaft, is 135 feet 3½ inches; or in other words the jack shaft is 11 feet 4 inches long, the warmer and calender

render the hose pliable. The inner tubes are made by hand, the experience of these people having shown this to be necessary. The tubes are two ply of rubber sheeting that has been previously doubled on the sheeter calender, making four layers of rubber for each inner tube. This sheeting, in the form of 5 by 22-inch strips, is rolled over the proper-sized mandrel, and when the first ply is ready the second is rolled over it so as to break joints with the first. The friction duck is then rolled over the tube, the coated side of the friction duck being against the tube. The union between the inner tube and the coated duck is complete, and in several samples that the writer picked up from a pile of hose on the floor the duck could not be separated from the rubber tube after unrolling the sheet without tearing the rubber apart.

The ends of the wrapped hose are capped, and a cover sheet of rubber is rolled on over the duck. The labels are then put on, the hose wrapped in a cloth envelope, and it is ready for vulcanizing. After vulcanizing it is stripped from the mandrels by air pressure. A nozzle is passed over the end of the mandrel and against the inner tube of the hose. The application of air pressure loosens the hose so that it may be easily drawn off. The vul-

canizing is done by keeping the hose in an iron cylinder filled with steam for the proper length of time. The cloth envelope referred to acts as a mold and tends to produce a smooth, regular surface on the finished hose. The hose is finished when the wrapping is stripped off after the vulcanizing is completed.

The air-brake hose is packed in boxes of 100 lengths, the usual output of the room being 1,400 pieces of 1¼-inch hose per day. Steam hose, corrugated and smooth, suction hose with wire inside, and hose for water is all made in this room, and the processes for all are similar in principle to that already described. About 32 men are employed in the hose room.

Mill No. 1 is the largest of the buildings. It is used for a large variety of work. At the center the small parts, such as gaskets for air-brake pumps, gauge-glass rings, pump valves, bib washers and valve packing are made and vulcanized. On one side considerable space is devoted to "Rainbow Packing," a product that has to a large extent revolutionized methods of packing manhole covers, valve connections and steam joints of all descriptions. Of the "Rainbow" flange packing, about 700 tons are sold per year. The basis for this packing is rubber which is compounded with other substances in such a way as to give the heat resisting qualities that recommend the packing so highly. The joints are completed and made tight without baking. The process is not unlike the preparation of sheet rubber except as to the mixing of the compounds, which is a secret known only to Mr. Dale and to Mr. Deming, the Superintendent. Hydraulic presses to the number of 24 are employed about the small work. These have three plates each and are fitted with steam connections for vulcanizing. There is much more that is interesting in mill No. 1, including the manufacture of tubular and square packing, rubber matting and diaphrams.

Mill No. 2 is the oldest building and is a reserve plant of six mills or grinders, two sets of calenders and the necessary washing facilities. It is run by an independent steam plant and may be used when necessary.

In mentioning the product of the establishment the diaphragms for vestibuled cars should be included as an important branch of the work. These are made by hand and evidently with the greatest care and skill, the starting point in the process being, as before, sheet rubber and duck. It is understood that all of the diaphragms, or bellows connections, for the Wagner and the Pullman sleeping cars are made here under patents held by the Peerless Company.

An air of contentment is very apparent among the men in the shops. They are working by the day, and not on piecework. A mutual aid association has been formed among them, with insurance benefits. The shops are well ventilated and admirably lighted by windows and by electricity. Special protection against fire is obtained by automatic sprinkler systems fed by an elevated tank, as well as an equipment of 10 hose houses with a total of 1,500 feet of fire hose. A pump is reserved for fire purposes only, and the men are organized for fire duty.

The plant is an interesting development from a small beginning. When Mr. Dale became connected with the concern in 1888, mill No. 1 was the whole plant and only 13 men were employed. Mr. Dale knew the railroad requirements of rubber goods and became interested in the business through a burst air-brake hose on the West Shore road, where he held the position of trainmaster. He became convinced that there would be a ready market for the best air-brake hose that could be made, and he has been engaged in trying to carry out this idea. The use of the hose by the Westinghouse Air Brake Company, the Pennsylvania, New York Central, Chicago, Milwaukee & St. Paul, and nearly all of the large roads, speaks for the success of the attempt. The hose for all purposes is tested at regular intervals and so severely as to insure the exposure of any weaknesses or defects. An English contemporary in commenting upon the quality of rubber goods says:

"We doubt the policy of buying cheap and nasty mechanical rubber."

We doubt it also.

The officers of the company are as follows; Mr. C. H. Dale, President; Mr. C. C. Miller, Treasurer; Mr. Brown Caldwell, Secretary; Mr. John H. Deming, Superintendent, and Mr. W. J. Courtney, Manager Railroad Department. We desire to acknowledge the courtesy of Mr. Dale and also of Mr. Deming for the opportunity to inspect the works and for the information obtained.

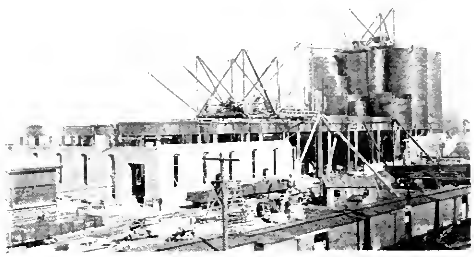
A New Method of Building Grain Elevators.

The engraving shown herewith was made from a photograph of the new grain elevator now building at Buffalo, N. Y., for the Great Northern Railway, under patents of Mr. D. A. Robinson. The method of construction is a radical departure from current practice in that the bins are cylindrical and of steel. There will be thirty bins in all, each having a capacity of about 100,000 bushels, giving a total capacity of 3,000,000 bushels to the complete elevator. The weight of the grain in these cylinders, which are 38 feet in diameter by 84 feet in height, necessitates extending the foundations to a depth of about 60 feet. The engraving shows small bins of 15 feet diameter between the larger ones. These are for the reception of the grain before it is placed in the large ones for storage. The whole system of bins rests upon steel work, which is placed above the foundation, and in the background of the engraving the bins have been carried to their full height. When completed the bins will be roofed over, giving the usual exterior appearance of an elevator. It is understood that the power employed in handling the grain will be taken from the Niagara Falls electric power plant.

Cost of Oil Fuel for Steam Boilers.

The trouble occasioned by the recent strike of coal miners has caused many steam users to investigate the question of the relative cost of oil and coal as a boiler fuel. Some interesting figures from Mr. Charles F. Foster, who was Mechanical Engineer of the World's Columbian Exposition, are printed in the *Engineering Record*, and we reprint the following valuable comparison and formula from that journal:

In determining equivalent costs of coal and oil for various prices paid for coal based upon the World's Fair results, we can establish



Great Northern Railway Elevator, Buffalo, N. Y.

a formula in which the price of the oil per gallon (A) multiplied by the number of gallons burned per horse-power hour (B) plus the cost of handling (C) is equal to the price of the coal per pound (D) multiplied by the number of pounds burned per horse-power hour (E) plus the cost of the handling (F), or

$$AB + C = DE + F$$

In this case $B = .3007$, $C = \$.0006$, $E = 4$ and $F = \$.00131$

$$\therefore D = \frac{.3007\,A - .00071}{4} = \$ \text{ per lb.}$$

Multiplying by 2,240 to obtain the cost in dollars per long ton (T) and symplifying, we have

$$T = 168.30\,A - .397.$$

Giving A various values from 1.5 cents to 3.5 cents, obtaining the value of T, we have the following table as showing the equivalent cost of coal per ton for oil at various prices per gallon, the evaporation and cost of handling each being taken the same as the World's Fair results.

Price of oil. Dollars per U. S. gallon.		Equivalent cost of coal in dollars per ton 2,240 pounds assuming the evaporation of coal to be $\frac{7.5}{14.25}$ of that of oil.	
.015	.0275	2.12	4.23
.0175	.300	2.55	4.65
.0200	.0325	2.97	5.07
.0225	.0350	3.39	5.49
.0250		3.81	

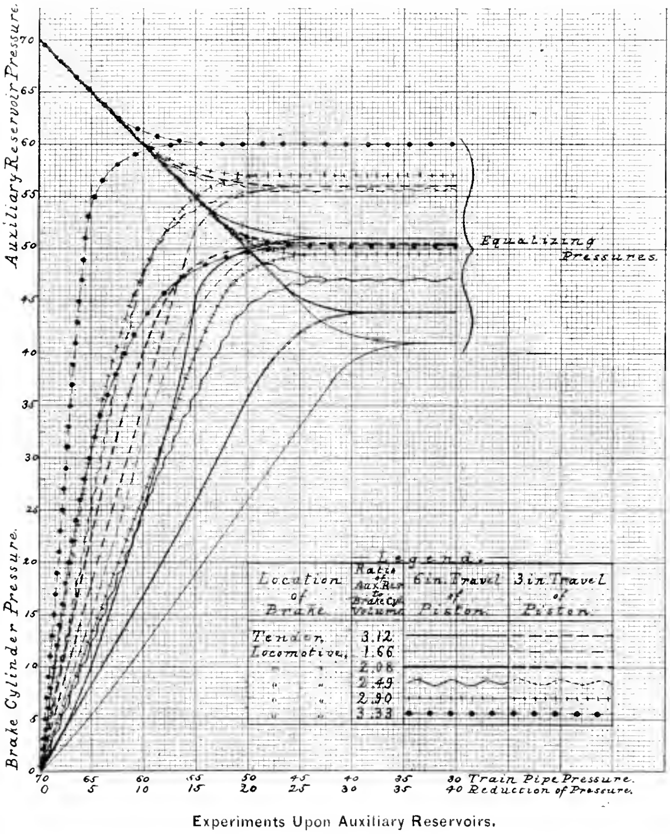
From the above it would seem that oil can seldom compete with coal when the question of price is concerned.

As far as the handling of the two are concerned, Mr. Foster found the cost of handling oil to be less than one-half the cost of handling coal. Were his figures applied to a smaller plant of, say, 500 horse-power in boilers, which would be capable of supplying a 1,000 horse-power compound engine and the plant run for 300 10-hour days, the cost of handling oil would be $900 and coal $1,965.

Experiments Upon Auxiliary Reservoirs.

BY G. R. HENDERSON.

The accompanying diagram gives a graphical representation of the effects of varying the capacity of the auxiliary reservoir for a given size of brake cylinder. The curves represent a travel of 3 and of 6 inches. Incidentally the effects of different reductions of train-pipe pressure are also illustrated. The experiments from which these curves were obtained were made for the purpose of determining practically the proper size of an auxiliary reservoir for operating the driver brakes of a locomotive. The engine had been fitted with two 12 by 10-inch brake cylinders and one 12 by 33 inch auxiliary reservoir, while the tender had an 8 by 12-inch cylinder and a 10 by 24-inch auxiliary reservoir. All were used as previously recommended by the Westinghouse Air Brake Company.



Experiments Upon Auxiliary Reservoirs.

It had been observed in service that the driver brakes did not hold properly when set with the regulation travel, and when the great disparity in volume between the engine and tender reservoirs relatively to their brake cylinders was considered, the reason at once became apparent. The volume of the tender reservoir was 3.12 times the volume of its single brake cylinder, while the volume of the engine reservoir was but 1.66 times the volume of its two brake cylinders. By comparing the fine and thick lines on the diagram it will be seen that while the tender brake equalized with 6-inch travel, at a pressure of 51 pounds, and with a reduction in train-pipe pressure of about 20 pounds, the driver brakes equalized at 41 pounds, and this necessitated a reduction in train-pipe pressure of over 30 pounds. For 3-inch travel, as shown by the dotted fine and thick lines, a similar discrepancy is found, and it will be noticed that 3-inch travel of the driver brake pistons gave approximately the same results as 6-inch travel of the tender brake piston. But a travel of 3 inches was too small to allow the brakeshoes to clear the wheels properly when the engine rolled in going around curves, which made it difficult to maintain the brakes.

Of course the proper ratio of volumes for the engine could be determined by calculation, but it was desired to make an actual test of the effect of varying the volume of the auxiliary reservoir on the locomotive. By coupling together different sizes and numbers of reservoirs, we obtained tests in which the auxiliary reservoir volume was 1.66, 2.08, 2.49, 2.90 and 3.33 times the volume of the two driver brake cylinders. The diagram gives a table designating the curves for each ratio, and it should be noted that the solid lines indicate 6-inch travel and the broken lines 3-inch travel of the brake pistons. The 2.90 ratio gave the closest approximation for the engine and tender at 3 and 6 inch travel, and as this was about equivalent to a 16 by 33 inch reservoir, this size was adopted.

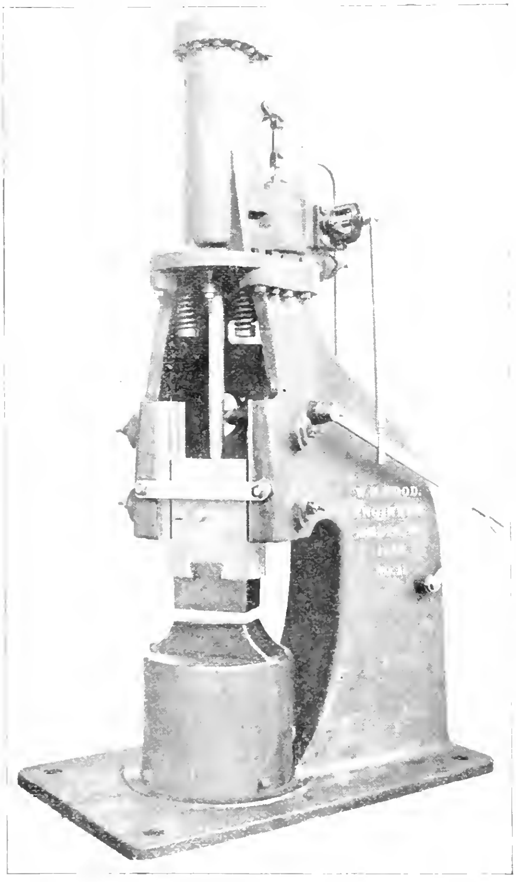
The effect of incorrectly proportioning the volume ratios may be readily seen from the diagram. The lines starting from the upper left-hand side of the chart show the auxiliary reservoir pressures, and those starting from the origin or lower left-hand corner show the brake cylinder pressures for various train-pipe pressures, measured along the axis of abscissas. As the train-pipe pressure is reduced, the auxiliary reservoir pressure falls in unison, the brake cylinder pressure rising, until the latter and the auxiliary reservoir pressure curves meet, when equalization is effected and the brake cylinder and auxiliary reservoir maintain one and the same pressure regardless of further reductions of the train-pipe pressure. This shows at a glance why it is useless and wasteful to reduce the train-pipe pressure more than 20 or 25 pounds, except when making an emergency application.

If, now, we consider the effect of the first-mentioned proportions of reservoirs and cylinders, it will be seen that while the heavy line shows 50 pounds cylinder pressure for 20 pounds reduction, or 50 pounds train-pipe pressure, the fine line shows but 26 pounds, and even if the train-pipe pressure be reduced to 30 pounds, we could obtain only 41 pounds in the driver brake cylinder. Of course the braking power will be proportionate to the brake cylinder pressures, provided the brake leverages are properly designed. A reduction of ten pounds in the train pipe would give 25 and 12 as the corresponding cylinder pressures. From the diagram we can therefore obtain the effects of various train-pipe reductions.

The importance of keeping the travel uniform is nicely illustrated by the chart. Let us imagine two tenders (or cars) in the same train; one has 3-inch travel and the other 6-inch travel. If now a reduction of 10 pounds is made, the brake with 6-inch travel will receive 25 pounds and the one with 3-inch travel 35 pounds pressure. (Follow up the 10 pounds reduction line to its intersection with the solid and broken heavy lines in the diagram.) A 20 pounds reduction causes equalization at 51 and 56 pounds respectively. A greater variation in travel would of course result in still greater discrepancies.

Wood's Single Standard Steam Hammer.

In the design of steam hammers the guides have constituted a special feature to which considerable attention has been given, and the form shown in the accompanying engravings has been arranged with a view of securing perfect alignment of the hammer head and to prevent the failure of piston rods through fatigue, which causes the breaking of many of these parts when put into the severe service expected of this class of machinery. The feature of this design is the patented guides, the construction of which will be understood by an examination of the photographic and sectional views. The section is taken through the frame, guides and hammer head.

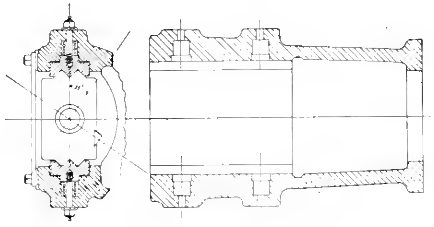


Wood's Steam Hammer.

In the standard in which the guides are formed and within which the hammer head works are vertical grooves with outwardly extending central apertured hubs on opposite sides. The guides for fitting in the vertical grooves have hubs on the back corresponding with the apertured recesses in the frame. On the back of each hub is placed a coiled spring which encircles the bolt which passes through the frame to the outside for adjusting the tension by the nut and lock nut on the guide against the hammer head, there being a small amount of clearance behind the guide and the main frame, which allows the vibration to be released at every blow, besides allowing the hammer head to adjust itself to any little irregularity that may occur while doing its work.

It will be readily understood from the photograph that the main frame of the hammer is of the ordinary type and that the cylinder and valve box are cast in one piece. The valve for working the hammer is of the annular type, which admits steam to the cylinder around the external circumference and exhausts through the center of the valve. It is fitted with a removable valve seat, so that it can be readily renewed. The valve is suspended on a lever attached to the rocker and connected directly to the shaft on which the handle with the trigger movement for working the hammer by hand or otherwise is attached.

The valve motion is very simple and the valve stem requires no packing. The piston is forged on the rod and is made of steel. The hammer head is of forged steel and the dies are of cast steel.



Section Through Guides.

The anvil is entirely separate from the hammer and is fitted in two parts so that in case of accident the top part can be renewed without taking the hammer apart. The base of the hammer, which is cast with the frame, is strongly reinforced and is ribbed below the floor line.

The patentee and builder is Mr. William H. Wood, Engineer, Media, Delaware County, Pa. He states that he had the requirements of railroad repair shops in mind when designing this hammer.

Communications.

Why Rails Break in Track.

EDITOR OF THE AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

In your September issue I notice a remarkable article on "Why Rails Break in Track," which, although very excellent in its way, seems to me to be going somewhat to extremes. Carry it a stage further and one might expect to see a rail twist up and break into fragments if it were looked at. In actual practice no such hair splitting is indulged in, as it would involve a large number of rejected rails, loss to the manufacturer, higher prices per ton, delays in filling orders, and other disadvantages which more than balance the slight danger of breaking in track. The method pursued by many roads is quite satisfactory, the rails being bought on a guarantee and replaced, when broken, by the manufacturer. What more can the railroad ask? The rail mill will furnish a good rail or be put to the expense of annoying replacements, and will furnish it cheaply, as it is then allowed to select the most economical method of manufacture, and is not treated as if the superintendent did not know the A B C's of his business, and was a rascal to boot, who had to be watched at every turn.

I will grant that the work done by Mr. Dudley is in the right direction, but how many roads in the United States are paying for such work and will the difference realized justify the expense? The next-door neighbor to the New York Central is the New Haven road, and if there is any difference in the roadbed and maintenance, I believe it is in favor of the latter, although it still follows the old fashioned methods. The proof of the pudding is in the eating, and although such nonsense as is to be found in the article referred to often finds its way into print, let us be thankful it gets no further. COMMON SENSE.

NEW YORK, September 10, 1897.

[Our correspondent is frank if severe. We recommend him to come out occasionally and see what is going on around him. Makers' guarantees will not prevent or pay for wrecks, but many accidents may be avoided by compelling care in manufacture, by making good specifications and by careful inspection. These may raise the price slightly, but a poor rail is dear at any price.

The almighty dollar cuts too large a figure in a great many departments of railroading.—EDITOR]

Locomotive Counterbalancing.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

I have your letter of September 8th. I regret to say that I have not time to write a full reply to Mr. Henderson's communication printed in your September issue.

One of the greatest defects of our American railroad system is that different departments do not work enough together. The mechanical department tries to make the machinery which will give the most economical results, no matter what the effect on the track and structures. The track department tries to get the track which can be most economically maintained, without reference to its effect on train service. Nor is this confined to these two departments; every department works too much on its own account.

It is a common thing for master mechanics to say that they have no evidence that the varying weight on locomotive driving wheels does any harm. The presumption always is that a varying weight does more harm than a uniform weight. It is a well-established fact that there are certain limits of strain to which material can be safely subjected—that any strains in excess of these causes rapid deterioration. If one locomotive has a uniform pressure at all times of say 16,000 pounds on a driving wheel and in another this varies from 8,000 to 24,000 pounds, the simple fact remains that the rails which carry the latter must be able to resist one-half greater strains than those which carry the former. If it is more economical and satisfactory to use the heavy rails, thereby throwing the expense on the track department, well and good, but until this additional cost of track is taken into consideration no fair comparison can be made.

It is possible to make a perfectly counterbalanced locomotive. The fact that this can be done is a reason why it should be done. There is no method of making a perfectly counterbalanced locomotive except by counterbalancing the revolving parts by revolving parts and the reciprocating parts by reciprocating parts. This may be done by the use of four cylinders, all taking steam at the same pressure, as in the old Shaw locomotive, or the four cylinders may be utilized to take advantage of the compounding system, as in the Strong locomotive, or it can be done by a reciprocating weight. The most economical results, so far as fuel and steam consumption are concerned, will undoubtedly be obtained by the compound locomotive. The other machines will be simpler; possibly, for many purposes, they are to be selected, though the details must be far different from those of the Shaw locomotive or any design which I have yet seen using a reciprocating weight.

I thank you for your advance proofs of what you have written on the boiler performance, and also on the weights on the driving wheels. You are certainly correct in stating that "common practice in counterbalancing is a compromising makeshift not to be proud of."

GEO. S. MORISON.

NEW YORK, Sept. 15, 1897.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

I have read with some surprise and a great deal of interest the letter of Mr. G. R. Henderson in your September issue, and can only account for the writing of such a letter on the ground of lack of information on the part of its author. It reminds me very much of a little incident that occurred some years ago on a certain Western road, which is interesting in this connection, where another man was equally confident with Mr. Henderson that his locomotive, or one under his charge, was the "best balanced locomotive on the road." A report had been sent into the office of the Superintendent of Motive Power that a lot of track had been spoiled on a division at some distance from headquarters, and two experts were sent out to make an investigation. They measured the distance between the bends on the rails and found they corresponded to the circumference of the driving wheels of a certain locomotive that was suspected of having done the damage. They then went to the Division Master Mechanic and told him that No. — had bent the rails, and that her counterweights would have to be looked after. The Master Mechanic replied that "that could not be, as she was the best balanced locomotive on the road and he could prove it." The experts asked how he proposed to prove it? "By taking her out and giving them a ride at 70 miles per hour, right away." They protested that this could not be done with their consent; but if he wished to do it at his own risk it would be all right. He said he would take all the risk, and ordered the engine out. They all got on, and went out about 10 miles to the top of a grade and started back, and came in at a very high rate of speed, no one on the engine noticing anything peculiar, but all agreeing that she rode very well, and when they had gotten back to the roundhouse and the engine was back in her stall, "Now, did I not tell you she was the best balanced engine on the road?" remarked the Master Mechanic, and they agreed with him and they went into the office and sat down to discuss it; but they had not been there very long before the foreman of that particular section entered the office with the remark, "Well, now, you fellows have just raised h—— with another five miles of track; the rails are so badly bent that they will all have to be taken up and new ones put down."

Now, that Master Mechanic had learned a lesson which should be useful to all railroad men, and especially to motive power men, that a good riding engine is not necessarily an easy engine on tracks and bridges. He was more excusable for his confidence in his belief that that particular engine was all right than Mr. Henderson is for the position that he takes, for he did not pretend to be an authority on counterbalancing, while Mr. Henderson does, as he informs us that he has read a paper before some engineering society, and then he goes on to show by his own figures that he is not acquainted with the first principles of counterbalancing, when he states that the remedy I propose " is like an antidote for a poison, instead of eliminating the poison altogether," and in the next sentence agrees that my arrangement of parts does perfectly what they are intended to do, and that the engine is perfectly balanced in every way. He complains that I have not eliminated the inertia of the parts that are made to balance one another.

Let us see what happens in this locomotive, and compare it with what happens on a locomotive such as he proposes. In the balanced locomotive that he refers to there are two pistons with their piston-rods, crossheads and one-half of their mainrods, of equal weight and as light as they can be made, always moving in opposite directions and coupled to the same axle at 180 degrees, and the pistons in the same saddle-casting and working on the same axle-box, about equally distant from the center of this axle-box, and having the revolving parts of the respective connecting rods and cranks balanced on the axle on the inside, and in the wheel on the outside at the same distance from the center of the axle, as the distance at which they revolve.

It makes no difference whether you suspend this axle on centers and allow it to stand in any position you wish to put it without any tendency for it to change position, or run it at 1,000 revolutions a minute, it is always balanced and there is no disposition to move up or down, or backward and forward; nor is there any pressure nor pound imparted to the axle-box or frame, nor to the track or roller, if it be mounted on rollers. The inertia of one part is absorbed and counteracts the inertia of the other part, within the cylinders by compression, and within the axle by pressure on the pins, but the disturbance does not go beyond the axle in any case, and, as the parts are made light by reason of the work being distributed over four cylinders, instead of two, the inertia that has to be stopped on the cranks is much reduced, and as there is no excess balance for reciprocating weight there is no disturbance of the center of revolution of the driving wheel.

Now let us compare this with the other method, of which Mr. Henderson claims to be the originator, but which is the same that has been in use since the days of Stephenson, and which all must acknowledge is a compromise, and no one can defend as being mechanically or mathematically correct, and which, while it has answered as a makeshift for slow speeds, becomes more troublesome as weights of locomotives increase and the public demands higher speeds.

He has designed a locomotive in which the reciprocating parts weigh, according to his figures, 696 pounds; he does not give us the weight of the engine, but he says that he proposes to allow $\frac{1}{150}$ part of its weight to remain as unbalanced reciprocating weight on each side of the engine. As he has not given the weight we cannot estimate just how much this is, but we assume that he has not departed from the rule of the Master Mechanics' Association, and that is to balance two-thirds of the reciprocating weight, which would be 464 pounds, and he states that this engine has 68-inch drivers, and that at 68 miles per hour it will not exceed 4,000 as the pressure in a vertical direction, due to excess balance at this speed.

Let us compare this statement with what occurs with a less amount of excess balance at a slower speed, as described by Professor Goss, in his report on the test of the balanced compound, as compared with another locomotive:

"To make the statement of the whole matter a trifle more technical, but vastly more comprehensive, it may be said that since the counterweights move in circular paths it is only the horizontal component of the radial force derived from them which can serve to neutralize the effect of the reciprocating parts; the *vertical* component of all that portion of the force which applies to reciprocating parts—that is, of the excess balance—is unbalanced. This unbalanced vertical component causes the pressure of the driver on the rail to vary with every revolution. If the counterweight revolves at uniform speed the radial force will be constant, but the value of the components will constantly vary, one increasing as the other diminishes.

"Whenever the speed of rotation is high, the unbalanced vertical component is, under conditions common in locomotive practice, of considerable magnitude, and its change in direction is so rapid that the resulting effect upon the rail is not inappropriately called a 'hammer blow.'

"A specific example will serve to illustrate this more fully. Assuming drivers of 63 inches in diameter running 60 miles an hour, every pound weight in the counterbalance will exert a centrifugal force of about 36 pounds. If the excess balance in any wheel for such an engine is equal to 400 pounds, the unbalanced vertical component reaches a maximum of more than 14,000 pounds, and it changes its direction from vertically upward to vertically downward at intervals of a tenth of a second. Again, if the conditions already assumed apply to an engine which has a load on each driver, when the engine is at rest, of 14 000 pounds, then, when running 60 miles an hour, the vertical component of the excess balance will just equal the static load upon the wheel; so that, at the instant the counterbalance is up, the wheel will entirely cease to press upon the rail, and when the counterbalance is down the wheel-pressure will be increased to 28,000 pounds; the change of pressure from nothing to 28,000 occurring, as already stated, in an interval of less than a tenth of a second.

"These statements, based upon assumed conditions, are sustained by theoretical consideration, and are fully confirmed by actual tests made upon an eight wheeled engine in the laboratory of Purdue University, which demonstrated the fact that the driver of an engine in which the condition of balance was not unusual, could be made to leave the track at every revolution."

If we assume that the excess balance in Mr. Henderson's locomotive is placed in the main driving wheel, to avoid the transmission of the disturbance through the side rod brasses and other connections, or in other words, to keep it as nearly to the source of its origin as the balancing of the reciprocating parts are balanced in the compound, we will have 464 pounds of excess balance traveling at a higher velocity than the 400 pounds of excess balance mentioned in Professor Goss' example, as a 68-inch wheel at 68 miles an hour is moving at a higher velocity, and its counterweights are moving at a higher velocity than the counterweights in the 63-inch wheel at 60 miles per hour. Then, if Professor Goss be right, we have 464 pounds multiplied by 36, or 16,704, as the disturbance in a vertical direction. If we assume that this weight is equally divided between two driving wheels, we will have one-half of 464, or 232, and at every revolution the brasses in the side rod, in addition to doing the regular work, will have to stop and start in another direction 232 pounds every one-tenth of a second; and in addition to this there remains on each side of the locomotive 232 pounds of unbalanced weight, which has to be stopped and started in the other direction on each one-tenth of a second, which force comes on the axle-box on to the frame, and from the frame is transmitted to every part of the locomotive and train, and can be felt at the fifth and sixth car from the locomotive.

Now, which is the correct method—that embodied in the balanced compound or that proposed by Mr. Henderson? I will leave the reader to be the judge. GEO. S. STRONG.

NEW YORK, Sept. 7, 1897.

[In order to consolidate the discussion of the counterbalancing matter the proof of Mr. Strong's communication was sent to Mr. Henderson, and his reply is given below.—EDITOR.]

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

I am under obligations to you for showing me in advance a proof of Mr. Strong's letter attacking my remarks about the Strong Compound Locomotive. I cannot claim to be entirely free from ignorance on some engineering matters, especially when it comes to advocating crank axles for locomotives as a desirable mechanism; I am perfectly ignorant of the advantages of such construction. However, the particular line of ignorance which Mr. Strong thinks of in his article is not clearly set forth in his letter, and I have not been able to discover wherein my ignorance in this particular point has been illustrated. I did not merely state that the engine seemed to ride easily and comfortably, but further on gave the value of the blow of the counterbalance as 4,000 pounds, which we believe will be admitted is not a severe impact to place on the ordinary rails which are used at the present date, and I will show further on that these figures are approximately correct.

When the Master Mechanics' Committee reporting at the convention of 1896 practically adopted my rules and suggestions in regard to counterbalancing locomotives (see pages 150 and 154, *Proceedings* of 1896), I felt as if I did not know a little on this subject, or at least that the committee thought I did, and I would be very glad to know how Mr. Strong was sharp enough to discover that I was not even acquainted with the first principles of the subject.

I certainly have no desire to detract from any of the glory due Mr. Stephenson or his work in the early days of the locomotive engine, but I have yet failed to discover that Mr. Stephenson recommended that the unbalanced reciprocating parts might be a definite proportion of the total weight of the engine.

The reason why I did not give the detailed weights in my previous article was that the reader should not be burdened with a needless array of figures, but as there may have been some misunderstanding caused by the omission, I will give them for the benefit of those interested. The engine in question has a gross weight of about 135,500 pounds, and $\frac{1}{340}$ part of this weight would be about 398 pounds. Mr. Strong assumes that we balanced two-thirds of these reciprocating weights and refers to an obsolete rule of the Master Mechanics' Association. The latest authority on this subject is probably given in the Master Mechanics' report of 1896, on page 151, in which no allusion is made to any fractional part of the reciprocating weights, but states that the unbalanced weights should be a function of the whole weight of the engine.

As the total amount of the reciprocating weight is, as stated previously, 696 pounds, the 398 pounds above mentioned substracted from this would leave 298 pounds of reciprocating weight to be balanced. If Mr. Strong will refer to the 151st page above mentioned, he will also see that this weight should be divided equally among all the driving wheels instead of placing it all in the main wheel, as he assumes that I have done. By following the rule given, this 298 pounds should be divided among three wheels (the engine being of the ten wheel type), which would, therefore, give 99 pounds to be placed in each wheel. As a matter of fact, however, the distribution did not come out exactly equal, but gave us as follows:

1st wheel	117 pounds.	
2d "	90 "	
3d "	91 "	of excess balance.

Thus it will be seen that the excess balance in any one wheel was not near the 464 pounds which Mr. Strong assumes that we had, but had a maximum value in first wheel of 117 pounds, and as this wheel had actually the lightest load due to the weight of the engine, it prevented an excessive total loading on any of the wheels. In order to obtain the effect of this excess balance at 68 miles per hour, we actually multiplied the above figures by 40 (see page 154, *M. M. Proceedings* 1896), which is greater than Professor Goss' value, which he placed at 36 pounds per pound excess balance when a 63-inch wheel was running at 60 miles per hour. The actual value would be really 38.4, but we take 40 pounds for the sake of even figures. This, it will be found, gives us a load due to the counter-balance, as follows:

1st wheel	4,680 pounds	
2d "	3,600 "	
3d "	3,640 "	at 68 miles per hour,

the wheels being 68 inches in diameter. The total maximum possible load then, including the static weight of the engine and the centrifugal effect of counterbalance, gives us from 18,000 to 23,000 pounds per wheel, which we hardly think would be excessive with the present strength of track.

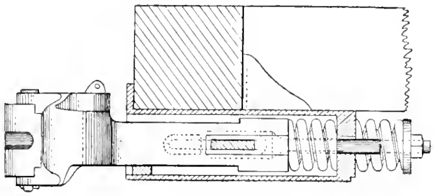
While of course we know and have stated that the four-cylinder method will give an approximate balance to reciprocating and revolving weights, both theoretically and practically, yet we cannot help feeling that the approximate method above outlined with two cylinders and their connected parts would be preferable under the majority of conditions both for construction and maintenance of equipment. G. R. HENDERSON.

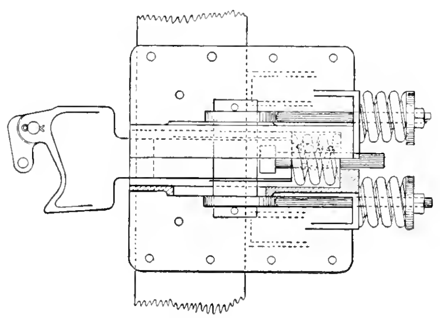
ROANOKE, Va., September 16, 1897.

A most remarkable record for fast time and punctuality has been made by the Philadelphia & Reading Atlantic City Flyer during the past summer. From July 2 to Aug. 31 the average running time for 55.5 miles was supposed to be 52 minutes, or an average speed of 64 miles an hour. Owing to ferry delays the actual time for 52 days was 48 minutes, or 69 miles an hour, and not once did the train arrive at Atlantic City late. On 22 days the train had five cars and on 30 days it had six cars. The performance called forth a complimentary letter from Vice-President Voorhees to the engine runner, and it was deserved, as the record is unique.

The Acme Tender Drawbar Pocket.

The locomotive tender drawbar pocket shown in the accompanying engravings was designed by Mr. R. M. Galbraith, General Master Mechanic of the St. Louis Southwestern Railway, and is controlled by the Western Railway Equipment Company of St. Louis. Mr. Galbraith has tested the device thoroughly, and says that its chief advantages are that a tender may be equipped with the ordinary M. C. B. freight-car coupler, which only requires 20 minutes' work for attachment after the tender has been equipped with the pocket. He says: "We find that it has the effect of relieving the engine from excessive jar when slack runs up, and it practically relieves the tender draft rods from





Acme Drawbar Pocket.

shock. We find that with its use repairs to the draft gear of our tenders have been very largely reduced."

The pocket casting is of malleable iron, with the proper provision for receiving the coupler shank and buffing spring. A key passes through a transverse slot in the coupler shank in a way similar to that of the continuous drawbar attachment. The looped ends of two side stems are passed over the ends of the key and held in position by cotters. These stems carry followers on their ends which bear against springs seated on the outside of the pocket casting for the purpose of transmitting pulling stresses. The pocket castings may be designed to fit any tender frame. The manufacturers believe that by the use of this device the pulling out of the tender draft rigging, except in bad wrecks, will be entirely avoided.

Rolled Steel Axles.

The Keystone Axle Company, of Pittsburgh, has recently made a successful test of its rolled steel axles at the plant, which is located at Morado, near Beaver Falls, Pa. The preparation of the plant has been in process for a long time and on Saturday, August 14, the first public test was made under the direction of the Pittsburgh Testing Laboratory. The roll in which the axles are made is 98 inches long by 48 inches in diameter. Dies shaped properly to give the axle its outline, and conforming to similar outline in the roll, form a backing against which the axle bears during the process. The space between the roll and the backing is wider at the point of entrance of the metal billet and gradually tapers down to the proper distance to give the rough finished dimensions to the axle.

The roll is turned by a direct connected 800 horse-power engine, built by the Philadelphia Engineering Company. The cylinder is 24 by 42 inches. Steam is furnished by 200 horse-power Brownell boilers. The furnace is so arranged as to heat continuously and has a capacity of 60 tons per day of 10 hours, the fuel being natural gas and coal. The plant is contained in a steel building 80 by 208 feet in size, which is conveniently located on the Pittsburgh, Ft. Wayne & Chicago Railway. The capacity of the present equipment is 600 axles per day of 24 hours. The following is the report of the test referred to:

Blows.	Deflections.
1	$5\frac{9}{16}$ inches
2	$6\frac{3}{32}$ "
3	$6\frac{3}{16}$ "
4	$6\frac{21}{32}$ "
5	$5\frac{13}{32}$ "

The distance between supports was 3 feet, the height of the drop 28 feet 6 inches, and the weight 1,640 pounds. The table of deflections gives those for the first five blows only, and other tests suggested by those present are said to have been satisfactorily met. The office of the company is in the *Times* Building, Pittsburgh. Mr. D. A. Clark is President and Mr. Thomas R. Torrence Secretary.

Tieplates.*

The result of observation and experience with the tie plate is, that when properly designed it is superior to the rail brace, in not only performing the function of the brace, but also in possessing additional merit of its own.

The function of the rail brace is to prevent the widening of the gauge by transmitting through the brace to the tie a part of the lateral thrust which otherwise would pass to the outer edge of the base of the rail, and also to prevent the outward turning of the rail in consequence of its cutting into the tie. The rail brace only partially accomplishes this. The rail brace does not prevent the rail from cutting into the tie, and when this is the condition much of the wheel pressure is transmitted through the head of the rail to the brace, making it a lever with the fulcrum near the base of the rail, and when in this position the spikes which secure it to the tie offer but little resistance to the track spreading or rail turning, a fact well known to every roadmaster. By using a properly designed tie plate the cutting of the tie may be prevented and the gauge maintained without the aid of the rail brace.

The extent to which the life of the tie may be prolonged by the use of the tie plate depends upon the traffic, the kind of tie timber, and a full knowledge of the existing or governing conditions. For example, on switch leads, where the track is in constant use, it would undoubtedly outlast several tie renewals; and on bridges, where the ties are more expensive, and where the labor renewing them is considerable, they are a wise economy. Also on main track under traffic where the ties are worn by abrasion due to the wave motion of the rail, the tie plate would undoubtedly prolong the life of hard-wood ties from one to three years, and soft wood from three to six years.

As smooth riding curves are desirable in practical track work as well as essential in general railroad operations, your committee believes that the use of the tieplate on hard-wood ties on curves of two degrees or more, and on all joint ties on tangents and curves of less than two degrees; also on soft-wood ties on tangents and light curves, a plate being on each tie, would result not only in a saving of labor and material, but in obtaining a higher standard of excellence, as next to rail, ties and ballast the tieplate is indispensable in securing good gauge, line and surface.

In addition to the saving, first, in rail, by reducing to a minimum the wear due to impacts and the uneven wear due to the rail getting out of position; and, second, in spikes, by fewer being cut by the vertical and lateral movement of the rail; and, third, in ties, by preventing the rail from cutting into them and by less spiking to rectify the gauge, thus prolonging their life and reducing the yearly renewals, which itself, your committee thinks, would warrant the favorable consideration of the plate, the advantage to be obtained by the use of the plate are better surface and gauge; the maintaining the rail in its normal position, enabling the motive power to be used more efficiently; the decreased wear and tear of rolling stock and the generally economical operation not only in the movement of freight, but also in safety to passengers. . . .

An essential feature of the tieplate is that it should have perfect

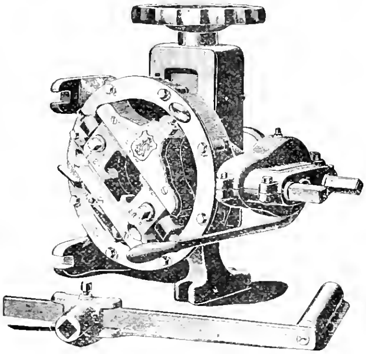
* From a committee report to the Roadmasters' Association of America 1897 convention.

mechanical union with the tie to prevent vertical and lateral movement, which would result in the working loose of the plate and widening of the gauge or spreading of the track. . . . In order to obtain the best results from the tieplate, it should be properly applied, the tie being well adzed to an even bearing for the plate, so as to decrease the tendency for it to buckle. It should be imbedded in the tie when applied and not left for the train to settle to position, thus exposing it to the liability of sand and gravel to get under to bend it. It should be so punched as to secure a snug fit to avoid any lateral movement of the rail, and the spikes should be driven vertically.

New Armstrong Pipe-Threading Machine.

The machine which we illustrate in the accompanying engraving is the outcome of frequent calls received by The Armstrong Manufacturing Company, for a machine threading from ¼ to 2-inch pipe, and the usual desire of that company to turn out a tool for this purpose superior in construction and operation to any heretofore manufactured.

It will be known as the Armstrong No. "0" pipe-threading machine and uses the well-known regular Armstrong adjustable dies which are put in the machine and adjusted in the same manner as in the hand stock. These dies can be opened after cutting a thread, and when the pipe is removed they may be locked back to the standard size without re-setting. This is



The New Armstrong Pipe Machine.

accomplished by an automatic locking device which is operated by simply pulling a knob. The dies, however, can be adjusted to the variations of the fittings, the same as in the stock.

All the gears and moving parts of the machine run in oil, being enclosed in a chamber which covers and protects them from chips and dust, doing away with any possible chance of chips and dirt getting into the gears. The machine is self-oiling in all its parts, oil being admitted through two holes which are closed by screw plugs. The die head has no teeth on the part where it fits into the shell and forms a bearing; in this way its bearing surface is preserved and it is impossible to work loose, a common occurrence with some makes of pipe-threading machines.

In addition to the die-carrying head forming a bearing in the manner shown, it has an inner journal, thereby increasing its wearing surface. A very powerful self-centering vise, which exerts its power from the center of the jaws and not on the side, is used with this machine and will hold the pipe, being threaded with a light pressure of the wheel.

The construction of the machine admits of its being attached to a post on the side of a building or to a bench. This is a very desirable and entirely new feature and one found in no other tool of its kind. Another, and one of the principal features of this machine, is its two speeds, a change from one to the other being effected by merely changing the crank from one spindle to the other. In one case the operator can cut from ⅛ to 1-inch pipe, inclusive, with great rapidity, then, by changing the crank to the other speed, from 1¼ to 2 inches, inclusive, thus avoiding the necessity of turning a great number of times on small pipe.

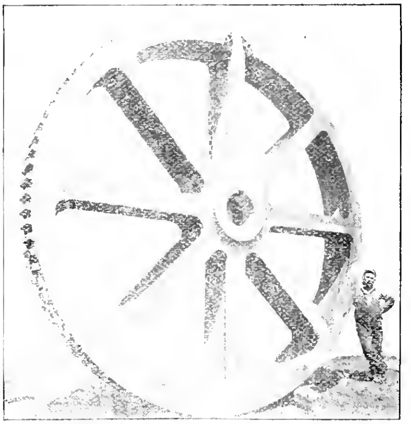
To operate this machine the vise is pushed back and the pipe is entered into the mouth of the dies, then by pressing the feed lever and turning the crank the pipe is fed into the dies. When the pipe is flush with the dies the small lever, shown on the under side of the die head in the engraving, is pressed toward the die which releases the locking device, and by pressing the knob on the opposite side the dies are thrown open. If the vise with the pipe is then pushed back and the knob pulled out, the dies are reset ready for threading another piece of pipe. The locking device adjusts itself automatically.

As this machine uses the regular adjustable dies, it can be furnished with dies for threading pipe from ⅛ to 2 inches, either right or left, or with bolt dies for threading from ¼ to 1½-inch rod, inclusive, also with dies for threading brass tubing and conduit pipe.

This new Armstrong Pipe-Threading Machine was shown at the Gas Exposition recently held in Madison Square Garden, New York City, where it attracted a great deal of attention and caused much favorable comment. Any further information which our readers may desire will be gladly furnished by The Armstrong Manufacturing Company, either at their factory in Bridgeport, Conn., or at the New York office, 139 Centre street. The company is also making this machine to work by power as well as by hand for use in large shops and mills.

The New York Railroad Club.

The subject of lubrication of cars and locomotives was discussed at the meeting of the New York Railroad Club which was held on the evening of Sept. 16. The introduction was by Mr. Charles Miller, President of the Galena Oil Works, whose remarks were chiefly directed toward emphasizing the importance of using lubricants of the best quality for the purpose mentioned. The lubricant for



A Large Cast-Steel Gear Wheel.

axles was likened to the use of rollers under heavy weights for the purpose of moving them and it was evident that the quality of the material of the roller had much to do with the ease of handling the weight. Hard wood was better than soft for rollers under a block of stone, and iron was better than hard wood. The speaker showed that it was important to attend to the matter of lubrication for several reasons, the chief of which being that it was economical in the end to use good oils, the repairs of equipment were less and the number of cars hauled were greater when good oils were used on the journals. Many motive power men were trying to save oil. He urged them to present the subject to the enginemen in the form of the desired increased mileage returns and would advise giving the men all the oil needed or asked for.

Mr. Mendenhall thought that the greatest saving in connection with lubrication was to be had by looking after the wasting of oil. It was not so important to save some of the oil actually used, but was very important to stop the wasting of oil.

Mr. Higgins believed that hot boxes were the result of mechan-

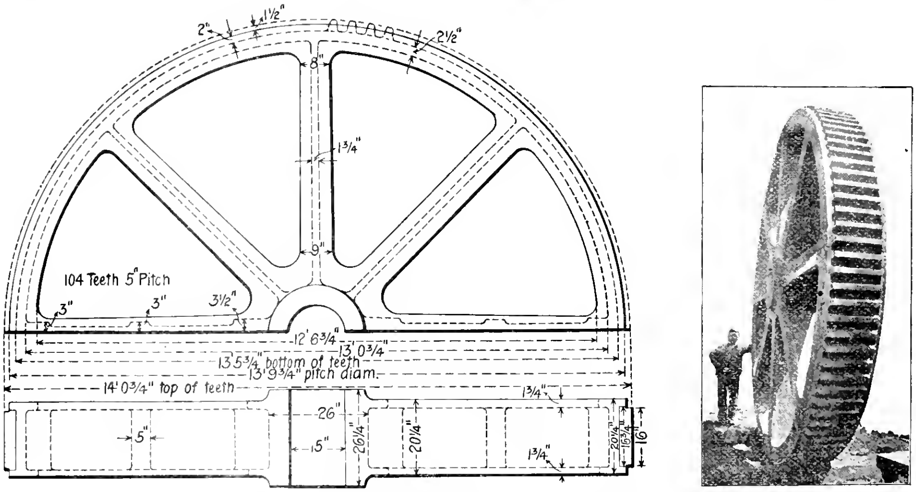
ical defects and the increased weights upon journals without proper provision for increasing the bearing surfaces. He had had good results from insisting that inspectors should let boxes alone when they were running satisfactorily, and he believed that there was no need of stirring up the packing unless a box ran hot. They were packed too often in ordinary practice. Mr. Forney raised the question of why oil lubricates bearing surfaces and was not satisfactorily answered.

After a brief discussion of the subject of copper spots on bearings and on improved oil records which had been secured by the use of good lubricants—which were always favorable to these lubricants—the meeting adjourned.

A Large Cast-Steel Gear Wheel—By the Sargent Company.

A drawing and photograph of a large gear wheel made in cast steel by the Sargent Company of Chicago have been received from that concern. It will be admitted that there are few more difficult castings to make than gear wheels, and when of such large size as this one, 13 feet 9¾ inches pitch diameter, the workmanship at the foundry and the furnace must be excellent in order to secure satisfactory results. The wheel weighs 28,175 pounds, and was made for the Great Western Tin Plate Company, of Joliet, Ill., the machine work being done by the Bates Iron Works of that city.

The diameter of the wheel is 14 feet ¾ inch over the teeth and 13 feet 5¾ inches at the bottom of the teeth. The width of face is 20¼ inches, and the teeth are 16 inches wide, shrouded as shown in the engravings. Other details of the design are clearly indicated, among which is the diameter of the shaft, 15 inches, and the length of the hub fit 26¼ inches. There are 104 teeth, the pitch being 5 inches. It is only a comparatively short time since cast steel would have been distrusted for such purposes as this, and the fact that a 14-ton wheel is made in this way shows that a complete change has been wrought in the confidence reposed in this material.



A Large Cast-Steel Gear Wheel by the Sargent Company.

The Railway Signaling Club.

The regular September meeting of the Railway Signaling Club was held at the Grand Union Hotel, New York, Sept. 11, with an attendance of about 30, the meeting being very successful.

The president in his opening remarks stated that the membership had increased to 71. He explained the action taken by the club with reference to the interlocking rules, and stated that those recommended by the club were under consideration by a committee of the American Railway Association. He urged action by the club along lines of recommendations for practice as being the most useful work that could be done, and in his remarks gave weight to the fact that the club was not a local one in any sense, though its meetings had heretofore been held in Chicago.

The report of a committee on primary batteries was read, giving the results of a series of tests on the Edison-Lalande, the Gordon and the ordinary gravity battery, the results showing the last mentioned to be far cheaper than the others, not only in first cost, but also in cost of operation per ampere hour.

The paper of the meeting, by Mr. Chas. Hansel, entitled "A Moral and Physical Agent in Safe Railway Travel," was then read and the meeting adjourned until evening.

In the evening the paper by Mr. Sperry, presented at the March meeting, was declared open for discussion simultaneously with that by Mr. Hansel, but though the session was long, only three general subjects were treated: colors for night signals, the advisability of using derails and the merits of electric locking. The result of the discussion on night signals was to refer the question to letter ballot for the members to make recommendations as to what ground the club should take on the question.

The derail matter was pretty thoroughly taken up and a tendency on the part of some of the members to question the advisability of using them was shown. Several members who formerly advocated the use of derails were now doubtful as to the net gain in safety, which had been thought to be attained by them. Positive opinions were not expressed, but it was shown to be advisable to secure reliable data as to the cases in which derails had saved accidents, the number to be compared with the number of accidents which had resulted directly from their use. Such figures were not now available, and it was necessary to have records in order to understand their real value. Considerable weight was given to English experience, in which, with an immense train mileage, very few accidents occurred. The perfection of discipline would render them entirely unnecessary.

Opinions differed with regard to electric locking. It was considered an absolute necessity, in order to render derailing switches safe, but members whose experience had been widest with it were convinced that the complicatons it brought into signal plants were a fatal obstacle. They were men who had used the earlier apparatus, however. The meeting adjourned until 7.30 Wednesday evening.

By courtesy of the Lehigh Valley Railroad and the National Switch & Signal Company, the club was invited to inspect the signaling of the road and the works of the Signal Company at Easton, Pa., on Wednesday, and was handsomely entertained by Mr. Hansel.

In the evening session the principal work done was to refer the question of the desirability of using derails to a special committee, Messrs. C. Hansel, W. H. Elliott and Henry Johnson. This committee was instructed to collect data with regard to accidents prevented and caused by derails, and was instructed to consider the question of electric locking and the proper distances between danger points and derails and between home and distant signals. Another committee, Messrs. H. M. Sperry, G. H. MacDonough and C. L. Addison, was appointed to report upon permissive block signals, the interlocking plants as suggested in Mr. Sperry's paper. Messrs. A. H. Rudd, W. W. Young and F. Rhea constitute a committee to report recommendations with regard to a number of mechanical details of interlocking mechanism.

On Thursday the club went from New York over the New York, New Haven & Hartford to Hartford for the purpose of inspecting the interlocking plant at that point and the third-rail system between Hartford and Berlin.

(Established 1832.)

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

28TH YEAR. 66TH YEAR.

PUBLISHED MONTHLY

BY

R. M. VAN ARSDALE,

MORSE BUILDING..NEW YORK

G. M. BASFORD, Editor.

OCTOBER, 1897.

Subscription.—*$2.00 a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union.*

Subscriptions for this paper will be received and copies kept for sale by the Post Office News Co., 217 Dearborn Street, Chicago, Ill.

EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Special Notice.—*As the* AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL *is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 25th day of each month.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* **When a subscriber changes his address** *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

The paper may be obtained and subscriptions for it sent to the following agencies: **Chicago,** *Post Office News Co., 217 Dearborn Street.* **London, Eng.,** *Sampson Low, Marston & Co., Limited St. Dunstan's House, Fetter Lane, E. C.*

Probably most of our readers have read the published accounts of the collision on the Denver & Rio Grande Railroad, in which the wreck was reported to have been set on fire by the explosion of a Pintsch gas tank under one of the cars. It is difficult for us to believe that a gas tank could explode in a wreck, and how the gas tank could set fire to anything any more than could the water cooler is a mystery. There is likely to be a strong odor of gas about the wreck of a car carrying the Pintsch equipment, and if the wreck should be set on fire it is possible that the gas might escape and burn, but the claim that a gas tank exploded and set fire to the wreck will be commented upon very briefly. It is absurd, ridiculous.

The life of an unskilled laborer from the standpoint of one of them is portrayed in a series of articles by Walter A. Wyckoff in *Scribner's Magazine*, which everyone should read. Sociologists theorize about the condition of the lowest class of laborers and statisticians present their case in a light which enlists sympathy and excites concern, but the author of these articles records the life itself as he found it during two years of experience as a common laborer working in various gangs. He has a deep purpose, is intensely in earnest and the combination of his subject and his style is irresistible in its effect upon the reader, forcing the conclusion that half the discomfort and discouragement of these men is to the majority unknown.

The problems of providing adequate rapid transit facilities in large cities are worthy objects for the exercise of the best of engineering skill. Different conditions are found in each large city, and one by one the demand for better short and long distance urban transportation compels each to take up the question for itself. Boston is just congratulating herself over the opening of one of the principal portions of its subway, and is busy with the project of an elevated railroad. New York is discussing the underground plan, and has just agreed with Brooklyn to allow the trolley and elevated railroad trains of the latter city to cross the East River Bridge. All of these are important schemes, but the rapid transit question is one that will not stay solved. It will come up again in a new way very soon, and it begins to look as if the provision for this sort of transportation would become a most important branch of engineering. In this connection the rapid growth of large cities is significant. Josiah Strong has shown in *The North American Review* that while 175 years were occupied by New York in gaining the first 33,000 people, a gain of 280,000 was shown during the next 50 years. The next 30 years showed a gain of 630,000, and the following 21 years, ending in 1890, one of 859,000. The population in 1890 was larger than any one of 28 great states of the Union. In 1790 only three per cent. of our population was urban; in 1890 the ratio was 29 per cent. London's great growth has been comparatively recent, four-fifths of it having been made during the present century. All this goes to show the tendency for people to flock to the cities, and the causes are easy to find. This is no new discovery, but it is probable that few people realize the rapid growth of cities. That is not our object, however, but to show the importance of the transit problem.

WEIGHTS ON DRIVING WHEELS AS RELATED TO COUNTERBALANCING.

The great weight of the modern locomotive, whether for freight or passenger service, has for a long time caused uneasiness on the part of bridge and track engineers, and the limitations placed upon the driving wheel loads have seriously handicapped motive power men in producing locomotives to meet the increasing severity of requirements for fast and prompt train service. The allowable weight on driving wheels is nearly always fixed before the design can be laid out and usually the limiting factor throughout is the ability of the tracks and bridges to stand the load. Recently a design was completed and it was found necessary to reduce the weight of the locomotive by nearly three tons in order to come within the stipulated loads. Most of it came out of the boiler where it could not well be spared. The capacity of a locomotive for fast heavy service depends very largely upon the boiler and it is desirable to increase the boiler power to the highest degree for another reason, that of economical operation. A prominent superintendent of motive power has said that the track is at fault, that the locomotives must be heavy and that they must run fast. The track in his opinion should be made ready for locomotives far heavier than those now used, and he believes that the increased earnings secured by heavier engines would pay the bill. Perhaps he is right, but we would ask him whether he is getting the best use of the weights now existing.

The limit of locomotive improvement upon present lines has undoubtedly been nearly if not quite reached. We have driving wheel loads of 24,000 pounds per wheel and boilers have been built for ordinary service within the past year with as much as 2,900 square feet of heating surface. A heating surface of nearly 2,500 square feet for a passenger engine, while not common, excites comparatively little comment. The new 10-wheel passenger engines for the Northern Pacific have 2,485 square feet of heating surface and, as indicated in the details of the design given in our June issue of the current volume, the weights are about as large as can be taken care of with the limitation of about 18,500 pounds per driving wheel. The tendency to turn to the 10-wheel type of engine for this design is caused by the necessity for providing great boiler power for the engine. The question now arises as to what is to come to the relief of the designer who is compelled to meet the next advance in requirements. The ad-

vantages to be gained by hauling heavy trains are so great as to practically compel the increase of power in locomotives although many bridge and maintenance of way engineers are now afraid that the thing has been carried too far. It may be taken for granted that some way must be found to reduce the wear and tear of locomotives upon the track. This would admit of increased wheel loads and would provide at once for an expansion of the boiler to a degree that would not only insure plenty of steam but would make it possible to operate the engine more economically.

These paragraphs are prompted by the prominence that has recently been given to the subject of locomotive counterbalancing, brought about by the tests of the balanced compound locomotive by Professor Goss at Purdue University. It has been highly interesting to read the comments which have been printed concerning the counterbalancing of locomotives and one apparently very important part of the question has thus far been entirely ignored or overlooked. That is, the effect of a perfect balance upon the design of the locomotive.

It would be hardly fair to say that various writers in the technical press underrate the importance of counterbalancing or that they uphold present practice on its merits, yet it seems strange that it does not occur to them at once that a perfectly balanced engine might safely be allowed from 15 to 25 per cent. more weight upon its driving wheels than is at present allowable. It is not enough to suggest that reciprocating parts must be lightened and that larger driving wheels should be used. The reciprocating parts ought to be lightened for reasons entirely outside the question of counterbalance, and it will be impossible to cure the evil in this way. As to the use of large wheels it may be said that they cannot be applied to freight engines, and therefore the counterbalance difficulty is not to be solved in that way.

It is not enough that the driving wheels should be kept down on the rails but, as we look at it, the important matter is to reduce the pressure upon the rail caused by the excess balance. Speeds of 68 miles per hour are not at all unusual, yet the additional weight of 4,000 pounds may be applied by the action of the excess balance to the load upon each driving wheel of an engine that is now considered very well balanced when running no faster than that. This may be considered as a remarkably good result. An extreme case is quoted from the paper by D. L. Barnes, read before the International Engineering Congress in 1893. In discussing the subject of reciprocating parts he says:

"It is not just to say that all American engines have such very heavy reciprocating parts as has been indicated here, but as a rule American engines have these parts much heavier than is necessary, and this leads to the excessive counterweights which have given ground for a just criticism of this feature of American locomotive design. For instance, some compound locomotives have been built in this country with a single piston weighing over 800 pounds. The builders did not realize at the time the result of this, and put in as much counterbalance as was necessary to make the engine ride well. The result was almost disastrous to the track at 60 miles an hour, the maximum pressure on the rail reaching nearly 50 000 pounds per wheel."

This was of course an extreme case of an overbalanced engine, but the effect upon the tracks of engines balanced as well as they may be, after the prevailing plan, must necessarily affect the tracks to greatly increase maintenance expenses, even if the rails are not actually kinked. It is probably not generally understood that the tracks of many of the best roads costs from $700 to $1,000 per mile annually for repairs.

Mr. Strong's design does not appeal to us as likely to be at all well received owing to the great number of parts. There are, for example, 16 glands on the engine as against four for one of the ordinary two-cylinder type. He has accomplished most valuable results in showing that a locomotive may be counterbalanced perfectly and in bringing the whole counterbalance question up for discussion again. It is no new subject, but on account of its bearing upon other vital factors in locomotive and track work it is more important now than before the locomotive had reached its present stage of development.

The best suggestion that we can offer is that the whole counterbalance question should be discussed in its relations to other important things beside the smooth riding of engines, the lifting of wheels or the actual indentation of rails. The American Society of Civil Engineers, the American Society of Mechanical Engineers and the American Railway Master Mechanics' Association could bring out the meat of the question if joint effort should be made, and the result of a thorough investigation of the subject would show whether heavier rails are necessary and whether locomotive weights may be increased. Common practice in counterbalancing is a compromising makeshift not to be proud of. If it is the best practicable plan it will survive, but there would appear to be so much depending upon counterbalancing as to warrant going into the question more deeply than has been done. The real merits of counterbalancing should be determined, and if we are correct in our view of the case a satisfactorily counterbalanced engine will be forthcoming if it is needed.

In this connection attention is called to the translated description of Herr Von Borries four-cylinder compounds, which appears elsewhere in this issue, together with his arguments showing the advantages of that type of locomotive.

THE ENGINEERS OF THE NAVY.

There is a strong probability that the important line and staff question in the navy will be taken up vigorously by Secretary Long in his annual report to Congress. Both he and Assistant Secretary Roosevelt are giving considerable time and attention to the matter, and it is to be hoped that the engineers will receive the recognition which they not only deserve but absolutely require for the proper discharge of their duties. A very important suggestion has just been offered by Prof. Ira N. Hollis, which, it is believed, is likely to be received favorably. It has the merit of a sensible solution of the problem, and its effect would be to place the officers of the navy on a basis consistent with the progress which has been made in the ships themselves. They are no longer sailing vessels, but machines for engineers, not old-time seamen, to handle.

If the suggestion becomes a law, the engineers' organization, as at present existing, will be abolished, and all officers will be educated at the academy exactly alike. They will all be taught the engineering and navigating studies, and there will be no distinct study of sailing navigation and engineering in the courses. A strong emphasis will be placed upon engineering, and in fact all officers will be engineers. Professor Hollis says in effect: Let the officers in command of the ships become engineers, and let the engineers rule or shipboard.

The work now performed by the staff would be done by the lower grades of the line officers, and an extension of the length of the course in the Naval Academy is included in order to permit of giving all of the cadets the necessary instruction in engineering subjects. The first six years of service will be devoted equally to the line and engineering work, and after 12 years of service officers may choose between the corps of chief engineers and the line. The chief engineers will have full charge of the mechanical appliances on the ship, and will be responsible to no one below the captain. They will not be obliged to spend any time in the actual running of the machinery, as that work will all be performed by the line officers, but they will be free to attend to the engineering of the ship. On the other hand, a chief engineer will cut himself off from any opportunity for promotion to command. His work will consist in the installation and maintenance of the machinery. This will probably be a very popular branch of the service, and the chief engineer will be, next to the captain, the most important officer on board a ship. The executive officer will command the crew as a fighting unit, and the engineer will be an engineer in fact as in name. The line officers will also all be engineers, having had 12 years of close contact with the machinery, and it is reasonable to suppose that they will be the better able to command for the experience that they will have with the elements that they will have to control.

The plan provides room for all of the members of the present engineer corps in the new corps of chief engineers after they have been in service 12 years, and there seems to be no reason to anticipate anything but good results if the scheme passes Congress. It seems probable that all of the friction existing at pres-

ent would be removed, and as far as a careful consideration of the proposition can show, there are no drawbacks connected with it. We have given considerable space to earlier discussions of this important subject, and are now glad to be able to say that a satisfactory solution seems to be possible. We cannot see wherein the present line officers can object to that which will undoubtedly improve the service, and it is possible that they may give the plan hearty support. Almost the same suggestion was advanced in 1863 by Gideon Weltes, then Secretary of the Navy. The time was not ripe for it then, but it is believed to be so now.

BOILER PERFORMANCE OF THE BALANCED COMPOUND LOCOMOTIVE.

Through the courtesy of Mr. Geo. S. Morison we have received a copy of the report by Professor Goss on the tests recently carried out at Purdue University on the balanced compound locomotive. The report is elaborate and is a characteristic example of the experimental work of Professor Goss in its clearness and thoroughness. The tests brought out a number of interesting facts concerning the boiler of the engine which are worthy of comment. The results of the engine test were disappointing and there seem to be several reasons why the engine did not do as well as was expected. The use of higher boiler pressure and probably a different setting of the valves would have been advisable. The facts are that the engine was entirely new and had not been sufficiently long in service to run smoothly. The valve gear and boiler were of unusual design and to expect the best combination of operating conditions to be determined upon for the first experiment would be rather unreasonable. Furthermore, for reasons not necessary to explain, the designer of the engine was not present at the tests nor had he any part in planning or executing them. The engine tests will be left out of consideration until we have records of further tests, which we hope will be carried out.

The boiler, frames, running gear and tender of this engine are the same as when the engine was known as the A. G. Darwin. The valve gear is a modification of the Walshaert, and the valves are similar in general construction to those used in the other engines of Mr. Strong's design. The boiler has been in use for a number of years, and was originally built for comparison with those of much lighter engines than are now considered up to date. The boiler has two Fox corrugated furnaces united at the forward ends by a corrugated combustion chamber or connection piece, at the forward end of which is the rear tube sheet. The tubes, 204 in number, are 10 feet 6 inches long and 2 inches outside diameter. The total heating surface of the engine is 1,280 square feet, and the grate area is 43.3 square feet. The test was carried out in connection with the counterbalance test on the locomotive testing plant at Purdue, and the usual methods of conducting such tests were followed. The coal was Brazil block and was perfectly dry, having been stored under roof for eight months. The analysis gave 51.09 per cent. fixed carbon, 38.93 volatile matter, 2.35 combined moisture and 7.63 per cent. of ash. The fire was very thin, a thickness of 3 inches being all that was found necessary, except when the greatest power was developed, when the thickness was about doubled. A peculiarity of the double firebox showed itself in the test. The fire was so clear that it was possible to see through the firebox and into the combustion chamber beyond when one of the fire doors was opened. The dimensions of the old laboratory locomotive, now known as Schenectady No. 1, which was formerly at Purdue, were such as to permit of very fair comparisons between an engine of ordinary construction and the balanced compound, and this is fortunate, for there are few tests which may be as easily compared. The heating surface of Schenectady was 1,214 square feet, as against 1,280 of the balanced engine, and the boiler pressure of the simple engine was 10 pounds lower than that of the compound. This pressure, however, will be seen to be far below good practice with compounds.

The balanced engine carries more water in its boiler, about 20,000 pounds weight of water, than the simple engine and it was shown in the test that it was very much less responsive to changes in the condition of the fire. This is not attributed to any of the peculiarities in construction, and it seems probable that if the water level could have been made lower with safety this effect would not have been so marked. The steam was not wetter than is usually found in locomotives, although considerable water appears to have been carried over into the cylinders after each stop.

The boiler may be classed in the wide firebox type, and the large grate area combined with the advantage obtained through having two fire doors, only one of which is opened at a time, would lead to the expectation of good evaporative performance; but the test showed not only a good evaporative performance, but an enormous capacity for evaporating water. The greatest evaporation amounted to 21,736 pounds of water per hour, which, as Professor Goss shows in his report, is equivalent to an evaporation of over 16 pounds of water per square foot of heating surface per hour. Mr. Strong states that the same boiler when tried in previous tests evaporated 6,000 gallons of water per hour, or nearly twice as much as Professor Goss shows in his test. This would appear to indicate that Professor Goss' figures do not by any means show the greatest evaporative capacity of the boiler. The highest record for water-tube boilers is believed to be 18.2 pounds of water per square foot of heating surface. This high rate was obtained on a Mosher boiler with a blast pressure of 12 inches of water. The balanced locomotive developed a horse-power on less than 2 feet of heating surface. The comparison of these figures with results obtained with the ordinary firebox boiler are marked. Professor Goss shows that the greatest amount of water ever evaporated in the boiler of Schenectady in an hour was 14,937 pounds, corresponding to 12.3 pounds per square foot of heating surface, or nearly 25 per cent. less than the balanced engine. Prof. Goss says: "Basing the comparison upon heating surface, therefore, it would appear that the capacity of the balanced locomotive boiler is more than one-third greater than that of a boiler having the same extent of heating surface of the ordinary type."

A corresponding effect on the evaporative efficiency would be expected, and in this the result is not disappointing. The equivalent evaporation per pound of coal went as high as nine pounds, and with but one slight exception it was always above eight pounds. This is contrary to previous experiences with locomotive and marine boilers, which, when forced, usually drop off very greatly in efficiency. An increase of 380 per cent. in the boiler power of the U. S. S. *Cushing* was accompanied by a reduction of economy of 45 per cent., and the efficiency of the boiler of Schenectady, when burning coal at the rate of 3,000 pounds per hour, is only about 60 per cent. of that shown when burning 600 pounds per hour. The case of the balanced engine, however, is noteworthy in that it gives about 90 per cent. of its maximum efficiency when burning coal at the rate of 3,000 pounds per hour. The rate of combustion was only about 75 pounds of coal per square foot of grate per hour, which is sufficient to account for much of the economy, but there must be other contributory causes for it. The fires were thin, as has been stated, and from the accounts of the tests there seems to have been no trouble to keep the grates properly covered. This bears out previous records of the same boiler with the old cylinders. The draft was light and Professor Goss says: "If the draft for the two locomotives were compared on the basis of pounds of steam generated per unit of time, the showing would be even more favorable to the balanced locomotive. Thus, if both boilers were required to deliver 10,000 pounds of steam per hour, the balanced engine would require but about half the draft which Schenectady would need." The smokebox temperatures were as high for the balanced engine as for the other, which would appear to indicate that more heat might be abstracted by the tube portion of the boiler. There was very little smoke from the balanced engine. The conclusions reached by Professor Goss with regard to the boiler are summed up as follows:

> The evaporative efficiency is high, exceeding that of the ordinary firebox boiler by an amount varying from 8 per cent. to 60 per cent., depending upon the power developed. The difference in evaporative efficiency in favor of the balanced locomotive, when compared with that of Schenectady, is greatest when the

power developed is greatest. The steam supplied by the boiler under constant conditions of running is as dry as that usually delivered from the boilers of locomotives. The capacity of the boiler is very high when compared with ordinary locomotive boilers having the same amount of heating surface. It is not known how its capacity compares with that of other boilers of the same weight. The strength of the boiler, assuming 150 pounds to be its safe maximum of pressure, is not sufficient to give the highest success in compound locomotive work. The behavior of the boiler resembles that of a stationary plant. It does not respond quickly to changes in the condition of the fire.

The boiler is probably safe at from 175 to 200 pounds pressure and it is evident that the forte of this boiler is in heavy loads. The work done by the boiler is specially interesting in view of the use of corrugated furnaces. The average gain in efficiency over a simple engine was stated in the report to be 14 per cent., which is an excellent showing under the circumstances. This result may be credited almost entirely to the boiler and the engine may give a better account of itself later.

NOTES.

Electrical cab service was successfully inaugurated in London August 23. The automobile carriage has been slow in coming before the English public, but it has at last been received cordially.

The 24-hour system of notation which is in use on the Intercolonial and Canadian Pacific Railways has been adopted by the Belgian government for its railroads.

The looomotives of the Wilmington & Northern Railroad that are fitted with electric headlights have also been equipped with electric lamps for the cab gages operated from the dynamo circuits.

A heavy passenger train in England, according to Mr. Charles Rous-Marten, is one that weighs 247 tons, and in the estimation of Mr. Geo. F. Bird, writing in *Cassier's Magazine*, one weighing 210 tons is a rather remarkable load.

The Boston subway was put into successful and satisfactory service on September 1. The entire work is not complete; the portion along the Common is the only part finished. The experiment is being watched with greatest interest.

Another torpedo boat, the *Rodgers*, is reported to have failed to meet the contract requirements at the first and second trials. The speed required was 24½ knots, and an accident to the machinery stopped the second trial. This sounds like the reports from the *Dupont* when undergoing the speed trials.

Some hemlock timbers 2 feet 6 inches square by 55 feet long were found in excavating for the South Union Station in Boston. It is supposed that this material has been buried for over a hundred years. It is perfectly sound and will be used again.

At the Alma Tube Works, of Walsall, England, the mill furnaces are heated by gas from producers, and an interesting feature of the method used is that the gas passes direct from the producers to the furnaces without being allowed to cool down, the furnace and producer being in one. The air is passed through a regenerator and considerable saving is found from the practice.

The recent establishment of railroad cab service by the Pennsylvania Railroad in New York City has been followed by the New York Cental & Hudson River and the Erie railroads by the introduction of a zone system of cheap carriage service. The prices will range from 25 cents to one dollar in zones of about 20 blocks radius. The carriages will be available for patrons of the road only and the plan appears to have been very well received.

The independent air pumps of the battleship *Massachusetts*, which are of the Blake duplex pattern, have been shown to require but one-eighth of one per cent. of the power of the main propelling engines of the ship. This is a remarkably low proportion. They hold a vacuum of 25 inches when running at a speed of 17 double strokes per minute, the slow speed constituting a strong recommendation for this type of air pump.

The practical advantages of feed-water heating and also of condensing were shown by Mr. G. C. Cunningham at the Toronto meeting of the British Asssciation. He said that by using Green economizers in an electric railway plant the feed water was heated to 250 degrees and was introduced at a pressure of 15 pounds. The value of condensing was given as the difference between 3.67 and 2.60 pounds of coal per horse-power hour.

The application of the time unit in connection with locomotive performance sheets is discussed by Geo. S. Hodgins in the *Railway Master Mechanic*. It is advocated in order to give due credit to the hardest worked engines. The ordinary terms are indefinite on account of omitting to take account of the length of time occupied in making the reported number of ton miles. The usual method is like expressing power with the omission of the factor of time, which is of course an absurdity.

The success and standing of a national organization of engineers—and this applies equally well to all technical organizations—depends very largely upon the work of the secretary. It is interesting to note that the Institution of Mechanical Engineers (England) has recently accepted the resignation of Mr. Alfred Bache, who has for over 43 years been its secretary, and who now retires on account of ill-health. The appreciation of his disinterested efforts in behalf of the Institution was expressed by a testimonial in the form of $15,000.

It is stated that the Japanese have made some remarkable experiments in connection with the best means of strengthening a hull against torpedo attack. Two hulls were prepared, each with an inner shell, the space between the two being in one case left empty, and in the other packed with bamboo. On exploding equal charges against the outer shell of each, the first-named hull had both outer and inner skins wrecked, while in the second case the inner skin escaped injury almost completely, though the bamboo packing was reduced to shreds.

A pneumatic attachment for opening locomotive cylinder cocks has been patented by Mr. J. W. Thomas, Jr., Assistant General Manager of the Nashville, Chattanooga & St. Louis Railway. A spiral spring tends to open the cocks, and the air pressure from the main reservoir acting on a small piston holds them closed. A small valve is provided so that the device may be operated by the engineman, and if the air pressure falls below 65 pounds the spring opens the cocks automatically and notifies him of the fact.

The English way of signaling railroads is admirably thorough, but it is fair to ask whether even such a good thing may not be overdone. The London & Northwestern, according to *The Railway Magazine*, has 17,000 signals lighted every night upon its lines, and a runner in taking a train from London to Crewe and back for his day's work is controlled by no less than 570 signals. Twenty-two semaphores upon a single bridge spanning four tracks is putting them in rather thickly, and the picture such a bridge presents is a striking argument in favor of simple signaling.

The most successful managers, says a sensible writer in *Machinery*, are those who manage men, not things. By selecting the right heads of departments, encouraging them to do their best by showing in a substantial manner that their work is appreciated, and devoting the time that is too often spent in trifling details in becoming familiar with the latest practice and methods, the manager or superintendent can suggest improvements to the various departments that far outweigh the whole cost of some of the details referred to.

An act intended to bring accidents on street railways under State supervision and responsibility took effect in Massachusetts recently. It provides that the inspectors appointed by the Railroad Commissioners to examine the roadbeds, tracks, stations, rolling stock, etc., of railroads, shall perform these duties with respect to street railways also, and in case the inspector finds any portion of the equipment of street railways to be not in strict compliance with law, or in a condition such as to endanger the safety of the public or employees, he shall so report in writing to the Commissioners, who are empowered to act accordingly. The inspectors also investigate and report all serious accidents.

The increasing use of steel in places where wrought iron was formerly employed has given rise to considerable difficulty when the steel returns to the scrap pile, because in working over the scrap, steel and iron will not mix under the hammer and bad welding results. To guard against this several roads make a practice of specifying that all steel used in car construction or similar work shall have the letter "S" stamped thereon in such a way as to enable the men in charge of the scrap to positively identify it. This is good practice, for the reason that it is almost impossible to distinguish steel from wrought iron by any tests except chemical ones.

It is not generally known, says the *Engineering and Mining Journal*, that James Watt proposed in 1783 a decimal system of weights and measures, but W. H. Preece, the eminent electrician, called attention to this in a lecture delivered at Greenock, Scotland, several months ago. Watt's unit length was based on the seconds pendulum: his unit weight was to be the unit cube filled with water. Watt visited Paris in 1786, and met La Place, Monge and other members of the committee of the Academy, who were then considering the question, and it is not unlikely that his ideas were used in the formulation of the existing metric system, which was adopted in 1801. The lengths of a seconds pendulum in the latitude of London does not vary much from a meter.

The business handled by the baggage department of the Union Station in Boston has been unusually extensive during the return of summer travel from the White Mountains and the shore resorts. The first week in September was phenomenal in this respect, the number of pieces of baggage handled having been more than 40,000. During the same week nearly 1,500 bicycles were checked. During the season now closing 22,146 bicycles have been checked. A good plan is followed in sorting trunks by check numbers. On the outside platform of the outward baggage room the space is divided into sections numbered from 1 through the various figures and ending with 0. A trunk having a check ending with the figure 7, for instance, like 14027, is placed in section 7: any check with a cypher for its final figure, like 75330, for example, is placed under 0 in the platform sections. In this way a baggageman can readily find any wished-for trunk, and much time may be saved, as well as temper, for it has been found by the baggagemen that the question of temper enters largely into the work of checking and handling of baggage.

In accordance with the desire of the Secretary of Agriculture to promote more extended experiments in the use of steel trackways on wagon roads, the office of Road Inquiries has made arrangements with the Cambria Iron Works, of Johnstown, Pa., for rolling special rails for this purpose, these arrangements to go into effect as soon as definite orders from responsible parties amounting to one mile of track are received. The directors of the Road Inquiry and engineers of the iron company, after much discussion, have, according to the New York *Sun*, agreed upon a plan of track which promises to meet all requirements. It uses no wood in construction, and no cross-ties for support, but consists of a simple inverted trough or channel of steel for each wheel, with a slightly raised head on the inside to guide the wheels, each channel resting in a bed of gravel, and the two tied together occasionally to prevent spreading. Special devices for remounting are provided at each joint. The bearing, or tread for wheels, is 8 inches wide, the thickness about $\frac{3}{16}$ of an inch. The weight of the structure is about 100 tons per mile of single-track road, and it will be furnished in small sections at the rate of \$3,500 per mile. The first order for track has been given by the New York State Agricultural Experiment Station.

The limited number of gas engines in use in America may be chiefly attributed to three causes: the high first cost compared with steam engines, the high price of gas and cheap coal. These conditions are changing rapidly, and are much more favorable than they were a few years ago. Coal in many places is dearer, wood is scarce, gas is much cheaper, and gas engines are better and much lower in cost. Formerly there were but one or two firms engaged in the manufacture of gas engines, and those of but small capacity. Now there are in America about 50 manufacturers bidding for work; many of them manufacturing but small units, while others are manufacturing engines as large as 100 horse-power, and if required are willing to undertake an installation as high as 750 horse-power. Perhaps the most notable installation in the world of a gas engine electric lighting station is at Belfast, Ireland, says W. F. Kelley. This municipality owns the gas plant, as well as the lighting station. It contains four 120 horse-power tandem double acting, two 60 horse-power single double acting and two 150 horse-power four-cylinder vertical single acting high speed gas engines. Reports from the engineer in charge show that the service has proven very satisfactory, and as gas is furnished at cost, the operation is more economical than any other form of motive power.

The deepest bore hole in existence is said to be at Parnschowitz, near Rybrick, Upper Silesia. It is 6,571 feet below the surface of the soil, and was made in a search for coal measures. The hole, according to *The Engineer*, was 12 inches in diameter at the beginning, and this was lined with a tube about 0.4 inch thick; at a depth of 230 feet, the bore was reduced to $8\frac{1}{4}$ inches in diameter, and thus continued for 351 feet. The greatest difficulty encountered was the great weight of the boring rods as the depth increased. Though steel was used at a depth of 6,560 feet, the total weight of the tools reached 30,155 pounds. Under this weight ruptures of the rods were frequent, and an accident of this nature finally stopped the work: about 4,500 feet of rods fell to the bottom, and, being jammed under a part of the tubing, it it was impossible to withdraw it. The diameter of the well at bottom was $2\frac{3}{4}$ inches. Temperature observations made showed 12 degrees Cent., or 53.6 degrees Fahr., at the surface, and at the depth of 6,571 feet the temperature reached 69.3 degrees Cent., or 157 degrees Fahr. This is equivalent to an average augmentation of heat of 1 degree Cent. for every 34.14 metres of depth or 1 degree Fahr. for every 63 feet. These figures differ slightly from those obtained in other deep borings. The increase of heat at Schladebach correspond to 1 degree Cent. in 35.45 metres: that at Sperenberg, near Berlin, to 1 degree Cent. in 32.51 metres; and at the artesian well of Grenelle, at Paris, which is only 1,797 feet deep, and furnishes water at a temperature of 27.70 degrees Cent., it is estimated that the increase of heat is equivalent to 1 degree Cent. in 31.83 metres.

Many proprietors of manufacturing plants look upon efficiency tests of steam plants which are working satisfactorily as unimportant and unnecessary; at least this is a fair inference to draw from the relatively small number of such tests that are made. In a large shop or mill an expert mechanical engineer can usually find so many ways in which money is leaking away as to make it worth while to employ him at regular intervals to look over the plant and report upon the practice followed. A well-known engineer who was recently examining a number of factory institutions discovered that in one of them a great deal more coal was used when the night fireman was on duty than the day man used in the same length of time, and the average horse-power during the day was somewhat larger than that of the night time. When this was remedied the plant was operated with a considerable saving over the former practice. This waste is but too common, and it may be said that only a thorough study of the operation of a plant would reveal such things. A tendency of manufacturing establishments is to grow up about the original plant and to increase by additions in a manner very much like the ordinary growth of a railroad switching or storage yard, without any definite system and without any thought of the wastefulness of the scattered elements and unnecessary duplications in the plant. One small factory plant comes to mind as an excellent illustration of this. The business had started in a small way about 15 years ago and now is a flourishing industry requiring more than four times the amount of steam power originally found adequate. Instead of putting this all into a single steam plant, which might easily have been done with the layout available, there are four small boiler plants and as many small engines. Comment upon this practice

is unnecessary; an examination by an engineer would enable this concern to save a great deal of money. To quote what is probably an extreme case, Mr. Charles E. Emery in a paper read before the American Society of Mechanical Engineers in 1895 showed how he was able to reduce the annual coal consumption of a large oil refinery from 64,000 tons to 32,000 tons. To do this he closed up one of four boiler houses.

Personals.

Mr. Edwin McNeill has retired from the Presidency of the Oregon Railroad & Navigation Co.

Mr. J. S. Chambers, Master Mechanic of the Illinois Central at Paducah, Ky., resigned Sept. 15.

Mr. R. L. Ettinger has been appointed Mechanical Engineer of the Big Four at Indianapolis, to succeed Mr. Mason Rickert, promoted.

Mr. W. P. Orland has been appointed Master Mechanic of the St. Louis Division of the Big Four, vice Mr. G. S. McKee, resigned.

Mr. H. A. Gillis, late Master Mechanic of the Norfolk & Western, has been appointed General Superintendent of the Richmond Locomotive Works.

Mr. H. G. Hudson has been appointed Master Mechanic of the Cairo Division of the Big Four, with headquarters at Mount Carmel, Ill., vice Mr. W. P. Orland, transferred.

Mr. A. L. Moler, formerly with the Cincinnati, Hamilton & Dayton, has been appointed Master Mechanic of the St. Louis, Peoria & Northern, with headquarters at Springfield, Ill.

Mr. W. E. Killen, Master Mechanic of the St. Louis, Chicago & St. Paul, has also been appointed Master Mechanic of the Chicago, Peoria & St. Louis; headquarters, Springfield, Ill.

Mr. W. J. Hemphill, Superintendent of Machinery of the Chicago, Peoria & St. Louis Railway, has resigned, to engage in the manufacture of woven wire fence at Jacksonville, Ill.

Mr. John S Thurman has been appointed Mechanical Engineer of the Missouri Pacific, St. Louis, Iron Mountain & Southern and Leased Lines, with headquarters at St. Louis.

Mr. Russell Sage has retired from the Presidency of the Iowa Central, and is succeeded by Mr. Horace J. Morse, of New York. Mr. Morse has been connected with the road for many years.

Mr. D. A. Fell, Sr., for several years Master Car Builder for the Lehigh & Susquehanna Division of the Central Railroad of New Jersey, died suddenly at his home in Wilkes-Barre, Pa., Aug. 27, at the age of 80.

Mr. Mason Rickett, formerly Assistant Mechanical Engineer of the Cleveland, Cincinnati, Chicago & St. Louis, has been appointed Master Mechanic of that road at Delaware, O., effective Sept. 1, to succeed Mr. J. A. Keegan.

Mr. David Patterson has been appointed Master Mechanic of the Southern Division of the Kansas City, Pittsburgh & Gulf, with headquarters at Shreveport, La. His jurisdiction will extend from Mena, Ark., to Port Arthur, Tex.

Mr. C. L. Mayne has been appointed General Superintendent of the Fitchburg, with headquartars in Boston, Mass., to succeed W. D. Ewing, resigned. Mr. Mayne was appointed Assistant Superintendent of the road several months ago.

Mr. E. W. Hayes has resigned as Superintendent of Motive Power of Machinery of the Fort Worth & Denver City at Fort Worth, Tex., and is succeeded by Mr. George K. Jackson, formerly Foreman of the shops at Wichita Falls, Tex.

Mr. Nat C. Dean, formerly with the Crane Company of Chicago, has been appointed Western Representative of the Fox Pressed Steel Equipment Company and the Carbon Steel Company, and will have offices at 1413 Fisher Building, Chicago.

Mr. Fred Mertsheimer has accepted the position of Superintendent of Motive Power of the Kansas City, Pittsburg & Gulf, with headquarters at Kansas City. Mr. Jas. Roberts, General Foreman of the Union Pacific shops at Armstrong, Kan., succeeds him.

Mr. Peter H Schreiber, Master Mechanic of the Chattanooga division of the Cincinnati, New Orleans & Texas Pacific, died at Chattanooga, Tenn., Sept. 9, from a stroke of apoplexy. He was born at Whitehall, Pa., July 24, 1851, and had been in railway service since 1869.

Mr. C F. Quincy, of the Q & C Company, Chicago, has been elected one of the Directors of the Iowa Central and also has been appointed Honorary Commissioner, for the State of Illinois, to the Trans-Mississippi and International Exposition to be held at Omaha, Neb., in 1898.

Mr. A. S. Cheever has resigned as Chief Engineer of the Fitchburg Railroad to engage in other business at Cleveland, O. He has been with the road for 17 years and has been Chief Engineer since November, 1890. Mr. F. O. Melcher, formerly Assistant Engineer, has succeeded him.

Benjamin Brewster, First Vice-President of the Chicago, Rock Island & Pacific, diedat his summer residence at Casenovia, N. Y., Sept. 4, at the age of 69 years. For a number of years he was President of the Keokuk & Des Moines, which is leased to the Chicago, Rock Island & Pacific.

The Hon. Thomas Rees Morgan, machinist, inventor and manufacturer, died suddenly of heart failure at his residence on Monday, Sept. 6. Mr. Morgen was born in Pennydarran, Merthyr Tydvil, Glamorganshire, Wales, March 31, 1834. At the time of his death he was President and principal owner of the Morgan Engineering Company, Alliance, O., and was a leading manufacturer.

It gives us pleasure to note that Mr. W. H. Elliott, Signal Engineer of the Chicago, Milwaukee & St. Paul, who has heretofore reported to the Mechanical Engineer of that road, now reports direct to the General Superintendent. This constitutes a substantial, encouraging recognition of the importance of signaling, and, while Mr. Elliott's duties are unchanged, it must necessarily prove advantageous to transact the business of the signal department as directly with the general officers as possible.

Books Received.

Tenth Annual Report of the Board of Mediation and Arbitration of the State of New York, 1897.

Poor's Manual of Railroads, 1897. Thirtieth annual number. H. V. & H. W. Poor, New York.

Modern Locomotives. Illustrations, Specifications and Details of Typical American and European Steam and Electric Locomotives, 1897. Published by the *Railroad Gazette*, 32 Park Place, New York. This book will be reviewed next month.

Universal Directory of Railway Officials, 1897. The Directory Publishing Company, 8 Catherine street, Strand, London.

Some Fundamental Propositions Relating to the Design of Frameworks. By Frank H. Cilley, S. B. Reprinted from the *Technology Quarterly*. Vol. X., No. 2. June, 1897.

New Publications.

Maximum Stresses in Framed Bridges. By William Cain, Member Am. Soc. C. E., Professor of Mathematics in the University of North Carolina. Van Nostrand's Science Series No. 38. Pp. 182; cloth. New York: D. Van Nostrand Company, 1897.

The first edition of this work was published in Van Nostrand's Magazine, in 1878, and had to do chiefly with the comparison of the weights of bridges and their most economical depths. These subjects have now been practically solved by bridge engineers, with the result of replacing many types that were formerly quite common with other forms that grew out of the older ones. The book in hand discusses the stresses in those types most used at present, both as to uniform and wheel loads. It is to be considered as either an independent short treatise or as an introduction to the larger treatises. The subject matter is arranged for the benefit of

students and is given in considerable detail. The explanations are accompanied by examples specially designed to bring out the ideas involved. The principal types of bridges treated are the Pratt and Howe trusses for through bridges and for deck spans, the Whipple and the lattice trusses and the Warren girder. An appendix presents the subject: Most economical height of trusses having parallel chords.

RAILWAY TRACK AND TRACK WORK. By E. E. Russell Tratman, A. M. Am. Soc. C. E., Associate Editor of *Engineering News*. 400 pages, over 200 illustrations: bound in red buckram. The *Engineering News* Publishing Company. New York, 1897. Price $3

This work has been a long time in preparation, and those who have been watching for its appearance will not be disappointed. It deals with the materials and standards of track construction and maintenance, and fills a long-felt want because there is no other modern book treating so fully of these subjects. While the requirements of engineers and roadmasters are given first consideration, the book will be very valuable to operating officers. Roadbed construction is treated in detail, and a great deal of attention is given to track material, rails, ties, rail joints, switches, frogs, fences, cattle guards and track tools. A number of subjects allied more or less closely to the subject of tracks have been considered, such, for instance, as bridge floors, coal and water stations, turntables, section houses and track signs. All of the foregoing subjects constitute Part I., and Part II. is devoted to track work, the chief divisions of the subject being as follows: Organization of the maintenance of way department, track laying and ballasting, drainage and ditching, track work for maintenance of gage, grades and curves, inspection and premium systems, switch, bridge and telegraph work, handling and clearing snow, wrecking, records and reports. There are also chapters discussing the relation of the track to the traffic which it carries, the protection of grade crossings and the design of yards. It will be seen that the book is comprehensive, and in fact it is a little too much so in some particulars. For example, the subject of railroad crossing protection by interlocking is a broad one of itself and is not to be properly handled by anyone in a few pages. A paragraph would have sufficed to show the relations between the track department and the maintenance of signals. The selection of the Gibbs system of protecting a crossing of a steam and a street railroad as an example of crossing protection appears strange, inasmuch as a less general application of interlocking principles could hardly be found. The subject of the construction of coal chutes, like that of interlocking, is interesting, and both add to the interest of the work, but the appropriateness of including these in a work on track is questionable. The only other criticism offered here is in the treatment of special devices. The author has selected several examples of a line of specialties with the effect of giving endorsement to only those shown. This method and the giving of names and addresses of manufacturers attracts attention to specific devices instead of to general principles for which such a book should and will be consulted. The book is so good and carries out its plan so well that these criticisms appear exceedingly small, yet they seem to be called for. The author is entirely at home when he is dealing with track and track methods, and in this particular the book seems to be destined to be a classic. He is an engineer writing for engineers, and he writes well. He is not dogmatic in regard to debated questions of practice, and he has evidently tried to make the value of the book as permanent as possible. With the slight exceptions noted he has succeeded admirably. It is not too much to say that no officer of a railroad having to do with track work in any of its branches can be up to date without this book. It is well indexed, well printed and bound and the illustrations are better than we have ever seen in a work of this character. They are uniformly excellent and are all that can be desired. While they are not large, they are perfectly clear and distinct, especially as to the dimensioning of working drawings. Two valuable tables of standard tracks on 53 railroads of the United States in the form of appendices complete the book.

THE ENGINEER'S SKETCH BOOK OF MECHANICAL MOVEMENTS, DEVICES, APPLIANCES, CONTRIVANCES AND DETAILS EMPLOYED IN THE DESIGN AND CONSTRUCTION OF MACHINERY FOR EVERY PURPOSE. By Thomas Walter Barber, Engineer. Third edition considerably enlarged. With 2,603 illustrations, descriptive notes and memoranda. London: E. & F. N. Spon. New York: Spon & Chamberlain, 12 Cortlandt street. 1897. Price, $4.

That this book has already been through two editions speaks for its value to those for whose use it was prepared. The author has put his experience of 25 years in the preparation of sketches and notes concerning mechanical movements and details of machine design into an exceedingly convenient form for the use of draftsmen to whom a mere suggestion of the way to reach a certain result is sufficient. In designing machinery the draftsman must rely chiefly upon his memory for ways of reaching certain results which he is seeking, and he is likely to run in ruts and not employ devices with which he has not personally come into contact. The author says, in the preface, that it is presented "in the hope that it will be found of service to others who are engaged in the head-splitting, exhausting work of scheming and devising machinery than which I can conceive of no head work more wearing and anxious." The book gives simple sketches on every right-hand page and a mere line or two of description on the opposite page, the sketches and descriptions being given corresponding numbers. "A sketch," the author says, "properly executed is to a practical man worth a folio of description, and it is to such that these pages are addressed." No attempt is made to give strength or dimensions. The additions are in the latter part of the book and constitute Part II., references being given to the sketches in Part I. We are glad to have the book in our library, and also to recommend it to draftsmen. To illustrate its use: Suppose a man to be designing a crane of some kind, he would find it exceedingly convenient to turn to this book and find forty-three outline sketches of cranes of various types, locomotive, floating and stationary, and it is likely that he would receive a suggestion or two from them. The list of sketches is weak in places, but taken as a whole it is a very valuable book for its special purpose. In these days of good engravings it is too bad that the cuts were not better executed.

PROCEEDINGS OF THE MASTER CAR BUILDERS' ASSOCIATION, Vol. 31. John W. Cloud, Secretary, Chicago. Price, $1.50.

There is little to be said about this volume that has not already been said about previous volumes of the proceedings. It is from the press of the Henry O Shepard Company, and is well printed, well illustrated and well bound. The subjects of the discussions have been brought to the attention of our readers through the reports of the convention at Old Point Comfort last June, and the prompt appearance of the official proceedings will please many people. Mr. Cloud and his assistants should be credited with more rapid work in getting out the proceedings of the Master Mechanics' and the Master Car Builders' Associations than is performed by the secretary of any other technical organization.

PRACTICAL HINTS FOR LIGHT RAILWAYS AT HOME AND ABROAD. By F. R. Johnson, M. Inst. C. E., F. R. G. S., Late Executive Engineer Assam Bengal Railway. 31 pp., illustrated. London: E. & F. N. Spon. New York: Spon & Chamberlain, 12 Cortlandt street. Price, $1.00.

This work is what its title indicates, a collection of hints for the construction and operation of light railways. The author is experienced in Indian railroad building and operation, and uses positive terms in regard to his suggestions. He advocates a gage of 2 feet or 2 feet 6 inches, and speeds of from 8 to 12 miles per hour as having the best chances of success, and does not appear to appreciate any advantage to be gained from using the gage, which is standard in the country in which the light railroads are built. Mr. Johnson prefers curves of 198, 330 and 660 feet radius, and ballast from 5 feet wide by 9 inches deep to 6 feet wide and 1 foot deep. The rails recommended are 35 pounds per yard and the wheel loads from 2½ to 3 tons per wheel. The subjects of rolling stock, trading and transshipment facilities, station equipment, cost and working complete the hints, and an appendix contains a resolution of the government of India regarding concessions for feeder railroads.

Trade Catalogues.

[In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. These are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

PORTABLE RAILWAY MATERIAL.—An eight-page pamphlet has been received from Arthur Koppel, manufacturer of portable railway material. It contains an illustrated description of Mr. Koppel's patented electric railway equipment. This system employs a portable track made in sections, to which the overhead trolley supports are secured at the proper intervals. The system was designed with a view of cheapness and adaptability to the field of light railways. The system includes an electric motor car, costing considerably less than a steam locomotive that is capable of hauling the

same load, and the electric motor car weighs less and will run satisfactorily on lighter rails. The pamphlet is interesting and shows the whole system, including the method of erecting the trolley wire. Mr. Koppel's address is 80 Broad street, New York.

The International Correspondence Schools, of Scranton, Pa., have sent us two pamphlets, one containing 1,000 testimonials from students, and the other containing information concerning the schools and the system of study. The testimonials are conveniently arranged alphabetically under the city in which the student sending the testimonial lives, whereby a prospective student may easily ascertain whether there are any of these in his vicinity. The other pamphlet contains a description of the courses of instruction, a list of the instructors, a history of the schools and a full description of the methods employed, which are admirably adapted to the requirements of those who for want of time and means are unable to attend the regular technical schools. The requirements of admission, rules for enrolling, prices of scholarships and other expenses are included. A second part is devoted to the details of the courses of study, and anyone who is not informed as to the work of these unique schools should take the trouble to look them up.

THE NEWBURGH ICE MACHINE AND ENGINE COMPANY, Newburgh, N. Y., has just issued a neat little catalogue of 64 pages, containing descriptions of Penney's ammonia ice machines, the new Pictet-oxide system, Whitehill-Corliss engines and steam power plants. This concern is managed by men who have long been identified with the ice machine and engine building interests, and are experts in their specialties. The pamphlet records the experience of the officers of the company, describes the practice and theory of the mechanical ice machine, and illustrates and describes the machinery furnished by this company. It also presents some remarks upon Corliss engines, and contains a number of engravings of different types of engines taken from photographs representing the latest and best practice. A large catalogue containing more complete information and giving the names of users of the engines will be sent upon application.

THE DETROIT LUBRICATOR COMPANY, of Detroit, Mich., has just issued a new standard size 43 page pamphlet illustrating and describing sight feed lubricators, plain lubricators, brass and glass oilers, oil injectors, low-water indicators, globe and radiator valves and other devices of similar character. The lubricating devices are made chiefly for use on stationary and hoisting engines, steam pumps, gas engines, air compressors and in fact all kinds of engines. Those for locomotives are not illustrated in this catalogue. The necessity for giving careful attention to lubrication of valves of engines is pointedly shown by a quotation, with indicator diagrams, taken from Mr. E. M. Herr's remarks before the Western Railway Club in January of this year. This will interest all steam users, and it will probably astonish many who may see it in this catalogue for the first time. Mr. Herr shows a loss of 206 horse-power on account of defective lubrication of a locomotive valve. This catalogue will be sent to any address upon application.

"The Detroit & Mackinac Railway, which runs from Bay City north along the coast of Lake Huron, offers special inducements this year to all lovers of the rod and gun. The brook trout season just ended has been the most successful one ever enjoyed in Lower Michigan. The bass fishing still continues and is of the best. Duck may be shot in September. Partridge and quail are very plentiful this year along the line. Deer had a good winter and spring, and will be in good condition and plentiful from November 8 to 30 inclusive, which is the open season this year. The Detroit & Mackinac Railway claims to have the best hunting and fishing in Lower Michigan and has good grounds for the claim." For further particulars address J. D. Hawks, President, Detroit.

Among the advertising novelties soon to be issued by the B. & O. is one which is sure to attract a great deal of attention. It is to be known as "The Book of The Royal Blue," and is to be issued monthly by Col. D. B. Martin, Manager of Passenger Traffic. It will be magazine size, filled with attractive half-tone illustrations and reading matter descriptive of the road.

Compressed Air on Jerome Park Reservoir Work.

The Ingersoll-Sergeant Drill Company has just received an order from J. B. McDonald and Andrew Onderdonk, contractors of the Jerome Park Reservoir, New York, for a large air compressor plant, duplicating the plant now in service, except that the plant ordered is larger and has both steam and air cylinders compounded.

This reservoir is being built for the purpose of increasing the storage capacity of the water supply of New York City. The dimensions will be about 3,800 feet long and 2,800 feet wide, and the reservoir will be excavated to a depth of 33 feet 6 inches. It will be necessary to excavate 3,165,000 cubic yards of solid rock, an immense undertaking.

Almost every mechanical appliance on the work is operated by compressed air. The original plant consisted of one Ingersoll-Sergeant duplex Corliss condensing air compressor, with steam cylinders 24 and 44 by 48 inches, two air cylinders 24¼ by 48 inches and capable of producing 540 horse power at the pressure of 80 pounds at the receiver. Fourteen drills, 14 hoisting engines and several pumps have been operated by the original plant exclusively by compressed air, and the additional plant will provide sufficient capacity to permit of doing all the work on that job by air power.

Von Borries Four-Cylinder Compound Locomotive.

[Translated for the AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL from an article by Herr Von Borries in Glasers' Annalen.]

GENERAL DESCRIPTION.

The following description of the working parts of a compound locomotive having two high and two low pressure cylinders will make the construction of the machine quite clear.

The locomotive has a high and a low pressure cylinder upon each side which makes the construction and arrangement so simple that it can be cast in a single piece. The two pistons, on either side, drive an inside and an outside crank respectively, which are set nearly but not quite opposite to each other, so that the pistons are always moving in practically the opposite directions to each other, and thus the line of moving forces of the reciprocating parts with the weights of the same are equalized.

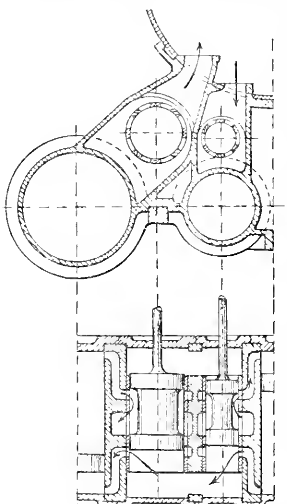


Fig. 1.

The two valves for each pair of cylinders are driven by a single valve motion, and the proper ratio of steam admission, upon which an economical use of the steam depends, is obtained by having two arrangements of valves. These valves are shown in Fig. 1, from which it will be seen that the valve of the high-pressure crank admits steam from the inside, while that of the low-pressure admits it from the outside.

In the first arrangement, as shown in Fig. 2, the crank of the low-pressure piston is opposite that of the corresponding high-pressure crank, with a slight angular advance in the direction of the rotation of the axle when the locomotive is moving ahead. This angular advance of the low-pressure crank brings it about that its piston reaches the end of its stroke a trifle earlier than the high-pressure piston, and its valve also has a little less outside lap than that of the high-pressure cylinder. The result of this smaller amount of lap is that the cut-off of the low-pressure cylinder occurs a little later in the stroke than that of the high-pressure cylinder.

Figure 3 shows the action of the valves by means of the Zeuner diagrams. AB is the stroke of the high-pressure and CD that of the low-pressure piston, set at an angle a with each other, as already mentioned. With an adjustment of the valve of the high-pressure cylinder which puts the point of cut off at a, for example (that is at half stroke), the valve of the low-pressure cylinder will be closed at the point b, with the crank in the position OC, so that the point of cut off will, in this instance, be equal to $\frac{Ce}{CD}$ (which, in the case in hand, will be about 0.7) and will be greater or later than the point of cut off of the high-pressure cylinder by the amount Oe. By a careful selection of the angle a

the proper angular advance to give the suitable cut-off ratio will be obtained.

For the valve motions shown, the openings of the valves are very different when the engine is backing, and this difference increases with the increase of the angle a. Hence, this angle should not be more than from five degrees to six degrees, since even with this a cut off of 40 per cent. in the high pressure cylinder will amount to 50 per cent. in the low-pressure, thus giving an actual expansion of the steam, before it is exhausted, of from 6 to 6½ times.

In the second arrangement the cranks are placed directly opposite each other; the steam valves of the two cylinders do not move together, however, but are driven from different points c and d of the main lever $a\ b$ of the valve motion, which is of the Heusinger von Waldegg type. The low-pressure valve-stem is attached at d, which is nearer to the connection of the radius bar than is that of the high-pressure valve-stem connection at c. With the same motion of the link s, the former has a shorter forward motion from the short arm of the lever $a\ d$ than has the latter from the long arm $a\ c$. The first, having less lap, therefore cuts off later than the second. This is shown in Fig. 5 by means of a Zeuner diagram. For the same point of cut off the centers of the two valve circles lie at the same distances above and below the center line, making $O\ e = O\ g$, since these distances involve the same motion for each. But horizontally the center n of the low-pressure valve circle lies about $\frac{g\ n}{e\ m} = \frac{a\ d}{a\ c}$ (Fig. 4) nearer the center O than that of the high-pressure, and as it has less lap the point of cut off is correspondingly later. The diagram shows that the ratio of the forward motion $\frac{g\ n}{e\ m} = 0.7$, a ratio which would make the point of cut off 0.6 in the low-pressure cylinder when it is 0.4 in the high-pressure.

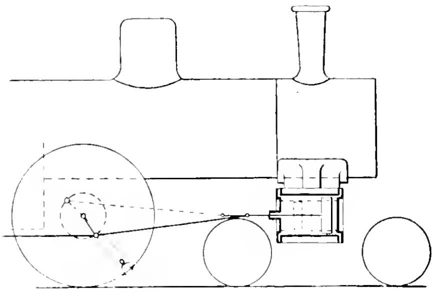


Fig. 2.

The following are the ratios of several points of cut off

High-pressure cylinder	0.3	0.4	0.5	0.7
Low-pressure cylinder................................	0.5	0.6	0.7	0.7½

which gives the most economical steam distribution that can be obtained in this way when both running directions are taken into consideration.

In the place of the Heusinger von Waldegg valve motion any other, the Joy for example, which has a main working lever, can be used, and in the place of piston valves the ordinary flat valves may be employed. The two steam cylinders on each side may also be cast in two pieces if desired, and a planed surface be made between them.

COMPARISON OF THE NEW LOCOMOTIVES WITH THOSE HERETOFORE BUILT.

The new arrangement described above offers the following advantages over the ordinary compound locomotives that have, up to this time, been built.

1. In comparison with the two-cylinder compound locomotives it admits of the use of a larger low-pressure cylinder, a higher rate of expansion and a better utilization of the steam at high speeds, as well as a greater tractive power, with the same rate of of expansion, upon grades. With two cylinders the piston area cannot exceed certain moderate dimensions, because the dimensions would be inconvenient and the working parts too large. We are, therefore, obliged to be content with a steam expansion from five to six times, while with the four cylinders a rate of expansion of from six to seven and a half is easily obtained when the point of cut off in the high-pressure cylinder ranges from 0.3 to 0.4 of the piston stroke.

The steam passages in the low-pressure cylinder can be made larger relatively to the piston area, so that the loss of pressure due to high velocities is diminished and the economical use of the steam consequently improved.

As the working of the pistons of each pair is in opposite directions the journals of the main driving axles, as well as the frames, are freed from a considerable portion of the stresses usually put upon them, there is less for the side rods to do and friction and wear are considerably reduced. It is not necessary that any fore and aft play should be allowed in the axle boxes, pounding is thus lessened, and on account of the reduction in the slip of the wheels upon the rail the number of flat spots are reduced—spots which formerly necessitated frequent turning of the driving wheels and thus increased the cost of the maintenance of the locomotive.

Since the opposite motion given to the reciprocating masses balance each other to a great extent, it is necessary to put but a very light counterbalance in the driving wheels. The centrifugal force of the counterweight acting vertically, which, with the two outside cylinders, may amount to as much as from 20 to 25 per cent. of the whole weight on the wheels, at high speeds, and which therefore tends to increase and decrease that weight at each revolution, this force becomes quite insignificant, so that the slipping due to it is correspondingly decreased.

This internal balancing of the forces and masses of the working parts results in a very quiet working of the machine and one that is free from pounding, so that wear is lessened and the mileage between two overhaulings of the machine increased. Since the regular overhauling of the engine is determined by the necessity of turning the tires of the driving wheels and the wear of the working parts, the cost of maintaining a locomotive is lowered in proportion to this increase of mileage.

The draft upon the fire is more evenly equalized with the four blasts for each revolution of the driving wheels than it is with the two blasts of the two-cylinder compound locomotive. Hence the coal consumption is somewhat less and the steaming qualities of the boiler improved, especially at high speeds.

2. In comparison with the four-cylinder locomotives of the Glehn system the arrangement of the parts will be found to be very much simpler, since there is a saving of two complete sets of valve motions, and the two cylinders being cast in one piece greatly simplifies the work of construction.

The tendency of the main axle to bend is greater than in the Glehn system, so long as the working pressure of the outside piston is not taken up by the side rods, and transferred to a pair of trailing wheels. But when the locomotive is hard at work and a pair of trailing wheels are used, which is the case in most instances, the tendency to bend will not be essentially increased by the piston pressure. In any case, however, the tendency is less than in loco-

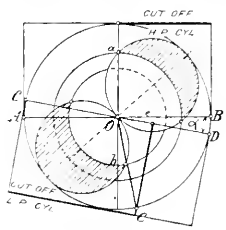


Fig. 3.

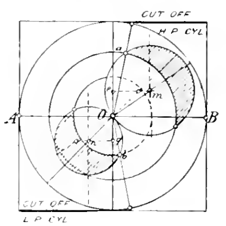


Fig. 5.

motives having two inside cylinders since the tractive power of those similarly located upon this locomotive is considerably less. When the great tendency of the driving wheels of these engines to twist and pound at high speeds are taken into consideration, the differences must become still less. The use of nickel steel in these axles has rendered them perfectly safe. In engines with six wheels coupled the front axle can be driven by the inside cylinders and the second by the outside, and thus a corresponding distribution of this tendency be obtained.

The working parts of the inside cylinders are as easy of access as the outside, because the outside cylinders are not in the way and the cross connections are between the frames. The construction of the frames is much simpler, which, being on the American plan, can be quickly disconnected from the cylinders.

On account of the important equalization of the opposite forces, at work upon the cranks, at the axle bearing and the corresponding steam pressures upon the cylinder heads of the two cylinders, the main frames and the cylinder fastenings can be correspondingly lighter.

The common steam chest, which serves as an intermediate receiver, avoids the loss of pressure and heat incident to the common construction of receiver. Thus the receiver pipe in the smokebox is done away with and without any loss, since its heating surface is so small that it is very inefficient.

The ratio of the point of cut off can be accurately adjusted to correspond to the relative areas of the two pistons and the speed of the engine, so that the most economical utilization of the steam will be obtained for both the forward and the backward motion by the arrangement of the Heusinger von Waldegg valve motion, as already described.

3. In comparison with the Vauclain four-cylinder compound locomotive as built by the Baldwin Locomotive Works, it has the advantage of being able to use an earlier point of cut off with less compression in the high-pressure cylinder, thus yielding a better utilization of the steam.

The principal defect in the Vauclain construction lies in the action of the heavy reciprocating parts moving in a horizontal line, which at the least calculation must be about twice as heavy as they would be upon two-cylinder locomotives. If, then, one-half of this weight is counterbalanced, the excess of weight due to the vertical component of the centrifugal force, when the wheels are making from 240 to 300 revolutions per minute, would range from 9,900 to 15,500 pounds. As the wheel weights must be increased and diminished by these forces at each revolution, it

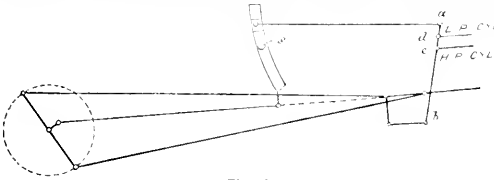


Fig. 4.

is evident that a very considerable stress must be put upon the track. In the design that has been described these forces are reduced to an insignificant quantity as the result of the equalization that is obtained.

The arguments against the use of crank axles should not enter into the consideration at all, since by the use of nickel steel they can be made perfectly safe and of ample strength.

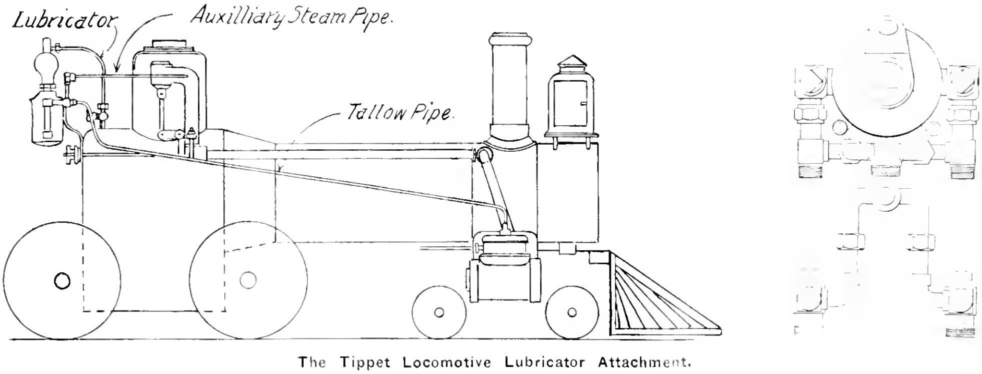
The disadvantages of this engine as compared with the Vauclain type lie in the increase in the number of parts, involving two valve seats, two stuffing boxes, two valve stems and two valves, while as an offset to this there is less strain upon the axle bearings and frames, as shown in comparison No. 2, and there is an entire avoidance of the tendency of the piston rods to bend and thus increase their own frictional resistance.

Lubrication of Locomotive Cylinders.

The fact that the manufacturers of locomotive sight-feed lubricators have been engaged upon the solution of the problem of getting oil down through the tallow pipes of locomotives while the throttle valve is open has been referred to in these pages. Our attention has been directed to a device brought out recently by the Detroit Lubricator Company for the purpose mentioned.

The engravings show the principal features of this improvement, known as the Tippett attachment, and in the opinion of the manufacturers it is the simplest and most effective device for the purpose so far designed. The manufacturers' attention was attracted to the communication on this subject on page 306 of the September issue, and state that the contingency referred to by our correspondent could not arise with this attachment in use.

It consists of a pipe leading to the dry pipe within the boiler and communicating with the two tallow pipes. As soon as the throttle is opened an extra current of steam is admitted into the tallow pipes, which is stated to effectually overcome the back pressure and create a current of steam in the tallow pipes toward the cylinders. Thus, as soon as the drop of oil rises through the sight-feed glass it is carried at once to the wearing parts, as intended. When the throttle is closed this extra current of steam is shut off, which would prevent the accumulation of steam in the cylinder.



The Tippet Locomotive Lubricator Attachment.

Four-Cylinder Compound—London and North Western Railway.

The latest locomotive designed by Mr. F. W. Webb is a four-cylinder compound known as the "Black Prince." The four-cylinder idea for a simple engine was worked out recently on that road, but the application of the compound principle to that number of cylinders is new in English practice. The heating surface is 1,400 square feet, and the working pressure is 175 pounds. The high-pressure cylinders are outside the frames and are both 15 inches in diameter. The low-pressure cylinders are between the frames, and are 14½ inches in diameter, the stroke of all cylinders being 24 inches. The Joy valve gear is used, the motion being taken from the connecting rods of the inside cylinders and rocking shafts are used to work the valves of the high-pressure cylinders, so that one motion answers for each pair of cylinders. The driving wheels are 7 feet in diameter and coupled, which is a novelty on the road. The distance between driving axle centers is 9 feet 8 inches. The truck wheels are 40 inches in diameter, and the use of a four wheel truck is to be commended. A curious practice is seen in the smokestack, which is double.

Ripper's Mean Pressure Indicator for High Speeds.

During a discussion of the subject of high-speed engines before the Institution of Mechanical Engineers (England), Prof. W. Ripper described a device invented by him for indicating such engines. It is the subject of a descriptive article in *The Engineer*, from which the following is taken:

The indicator diagram obtained from an engine running at high rotational speeds is usually a very imperfect record of what actually takes place in the engine cylinder, even with the best of indicators of the ordinary type, owing chiefly to the error introduced by the inertia of the moving parts of the indicator. This error increases as the speed increases, and for torpedo boat, electric light, and other high-speed purposes, a statement of the indicated horse-power is accepted as approximate only, and in many cases the attempt to obtain it is practically abandoned.

For many reasons the abandonment of the indicated horse-power unit of measurement is much to be regretted, and with a view to solving the problem of obtaining the mean effective pressure on the piston at all speeds, however high, the instrument here described has been devised.

The arrangement will be understood from Figs. 1 and 2. The

instrument consists of two barrels, in each of which works a piston valve over ports in the barrels. The barrels are each surrounded by a chamber, to which is connected a pressure gage for recording the pressure of the steam entering the chamber. The valves are arranged to work so that the chamber surrounding one barrel is connected continuously with the steam side of the piston only, while the chamber surrounding the other barrel is connected continuously with the exhaust side of the piston only. The mean pressure in the first chamber is the mean pressure on the steam side of the piston: and that in the second chamber is the mean pressure on the exhaust side of the piston. The pressures in the respective chambers are recorded by a pressure gage attached to each chamber: the oscillations of the finger of the gage are reduced to a minimum by throttling down the gage cock, as is now done with the gages on the receivers of compound engines, and with vacuum gages.

Instead of two separate gages a single differential pressure gage may be used, as shown in Fig. 2, from which the average pressure difference on the two sides of the piston may be read directly. The higher the speed of the engine the less the angle of the oscillation of the gage pointer, and the less need for throttling the gage cocks in order to read the M.E.P.

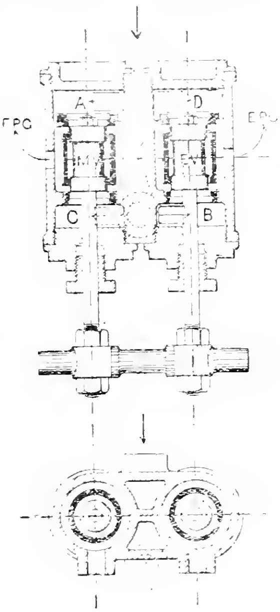


Fig. 1.

The action of the valve is as follows: M V is the main steam valve, and E V is the exhaust steam valve. The pipes leading

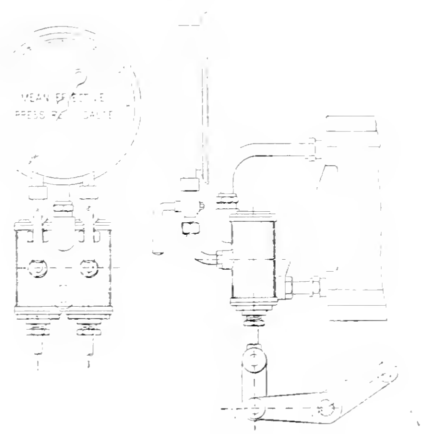


Fig. 2.

from each end of the engine cylinder are so arranged that each connects one end of one indicator barrel with the opposite end of the other barrel, as shown by the arrows. The valves are shown in mid-position, which is their correct position when the engine piston is at the end of its stroke. Both valves move together, and are worked by the same lever.

Suppose steam admitted to the top side of a vertical engine cylinder when the piston is at the top of its stroke, then admission steam enters the instrument at A and B, and steam from the exhaust side of the piston enters at C and D. The valves M V and E V now move downward—see Fig. 1—uncovering their respective ports and communicating the admission steam pressure to the forward pressure gage, F P G, while at B, the port being shut, no steam from this side of the piston can influence the exhaust pressure gage, E P G. Meanwhile, the steam from the exhaust side of the engine entered the instrument at C and D. At C the port is closed, and there is no connection with the forward pressure gage, F P G, while at D the port is open and direct communication is made between the exhaust steam and the exhaust pressure gage, E P G. In both cases the respective ports are open during the full stroke of the piston. On the return stroke the admission steam and the exhaust steam again communicate directly with their respective pressure gages throughout the whole length of the stroke.

The piston valves of the indicator are without lap, and they may be worked by a lever connected with an eccentric set at 90 degrees ahead of engine crank, or by an equivalent motion, which may be easily obtained without an eccentric in an engine having the main cranks at right angles. The instrument may be made to run continuously, as there are no working parts to get out of order: or it may be made to record a continuous mean pressure line on a continuously rotating drum.

Large vs. Small Locomotive Valves.

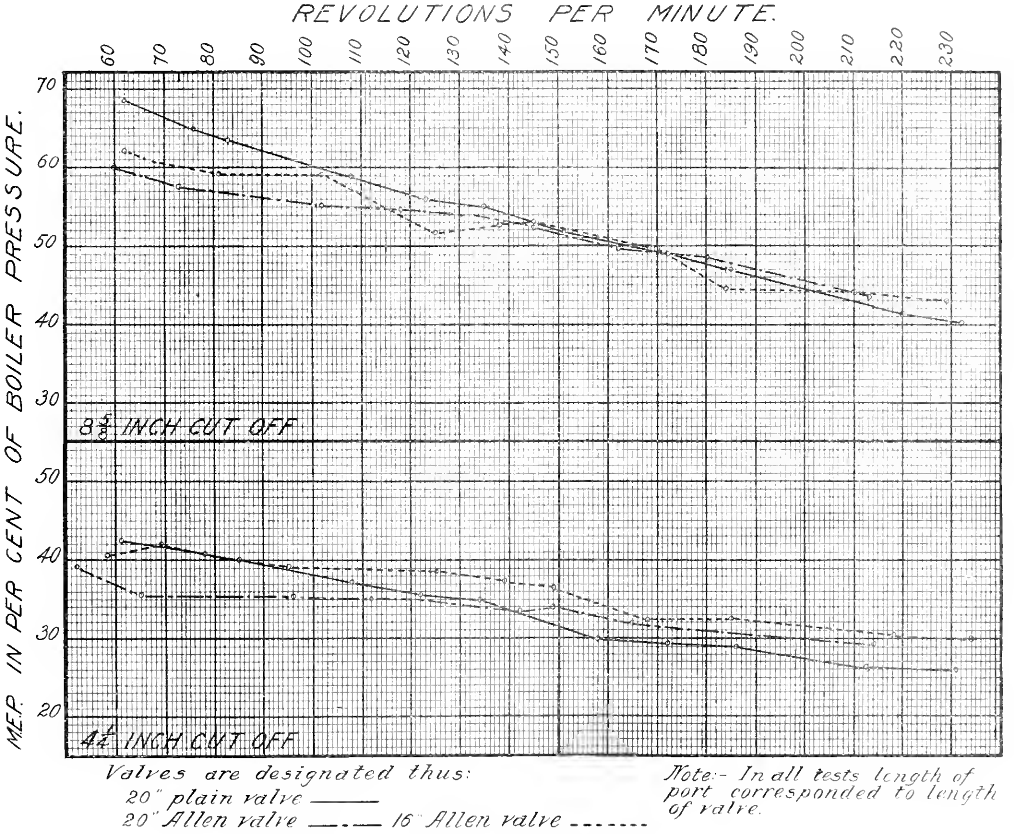
The distribution of steam in locomotive cylinders at high speeds is an important subject which has much to do with the economical working of the engine, and in the hope of improving the distribution recent practice has tended toward the use of very large ports and consequently very large valves. The direct object of this practice is to enable the steam to get into and out of the cylinder with as little hindrance as possible. Steam ports 20 inches long are quite commonly employed and have not been considered too long. To even suggest that it is possible to go too far in the direction of large passages must appear to many to be heretical, but in the light of some tests recently carried out on the Chicago & North Western locomotive testing plant it may be safely said that there is much that is not yet understood with regard to the action of steam in its passage between the boiler and the cylinder. These tests were conducted for the purpose of showing the comparative values of small and large ports on the proportion of the mean effective pressure to the boiler pressure and the results are very interesting.

The large Class A 8-wheel passenger engines of this road have 20-inch steam ports (the general dimensions of the engine were given on page 4 of our issue of January, 1896). The valve seats are false, and a smaller port 16 inches in length was tried on one of the engines with highly satisfactory results. Several of these large engines are now running with 16-inch Allen valves in place of the 20-inch plain valves formerly used, and they are reported to be doing very much better in actual service than the same engines did with the 20-inch plain valves. They are also better than any other engines of their class, and one of them is hauling train No. 1—the limited—from Chicago to Clinton, Ia., daily, and is always on time although the train often consists of 12 cars. No perfectly satisfactory explanation has yet been given for this fact or for its corroboration in the tests upon the testing plant, but the subject is presented because of its interest and importance, and we acknowledge the courtesy of Mr. Robert Quayle for generously supplying the information before he had been able to satisfy himself as to all its bearings.

The shop tests were made on engine No. 901 and the results show the relation between the mean effective and boiler pressure at various speeds and cut-offs. The tests were run in three series, first with 20-inch plain valves, second with 20-inch Allen valves and third with 16-inch Allen valves. The results of the tests are given in detail in three pairs of diagrams. Vertical rulings indicate the point of cut-off and the speeds in revolutions per minute are shown in a curve alongside of which is the curve of mean effec-

tive pressure in percentage of boiler pressure. From the individual records the diagram shown in our illustration was prepared, the points of cut-off chosen being 4¼ and 8⅝ inches as indicated in the two portions of the diagram. The three curves and key for them appear at the bottom of the engraving.

These curves show that under certain conditions of speed and cut-off the 16-inch Allen valve seems to be superior to a 20-inch Allen valve. This is a difficult matter to explain, as it appears paradoxical, but we have the testimony of the experience on the road to justify the conclusion that the tests are above criticism. It is not claimed from these tests that a 16-inch Allen valve is actually better than a 20-inch Allen valve as far as the steam cannot, therefore, be attributed to the action of clearance. It seems very probable that the springing of the parts of the valve gear with the large valves is to blame for some of the difference. The port openings at short cut-offs are very narrow, and slight variations in the working of the valve, motion, which are very small in themselves, would be large in proportion to the total port opening of the valve. Professor Goss has demonstrated that on the "Schenectady" with comparatively low boiler pressure the variation of the port opening was 30 per cent. of the average, which of itself would be great enough to produce an extensive change in the character of the indicator cards, and consequently in the mean effective pressure. The effect of insufficient lubrication of valves was very clearly shown by Mr. E. M. Herr in a paper read before the Western Railway Club and reproduced on



Tests Comparing Large with Small Locomotive Valves.

pressure is concerned, but the road experience and the results on the testing plant show that the shorter valve is as good as the longer one. From an inspection of the indicator diagrams it does not appear that the back pressure is materially affected by the shortening of the port, and one reason why the 16-inch Allen valve in general does better than the 20-inch plain valve and as well as the 20-inch Allen valve may be that the area of the admission ports to the earlier cut-offs is capable of supplying all of the steam that can get through the pipes or ports.

Surface condensation might be blamed as the cause of some of the loss from large ports, and with the large amount of metal near by to conduct the heat away some may be tempted to distrust large steam pipes and passages. It must be remembered, however, that the passages in this case were not altered, the valve and valve seat alone having been changed. The difference

page 86 of the March issue 1896 of this journal. In this connecnection it is worth noting that in September of last year Mr. Herr stated before the same club that he had frequently seen indicator cards in which the mean effective pressure was reduced one-half through the springing of the valve motion. He said: "This in my opinion may be the reason why an engine may sometimes not pull as well as a smaller engine, the larger engine, if the valves move hard, not getting enough steam into the cylinders to give enough power to move itself and the train."

The experience on the Chicago & North Western will interest our readers and if others have had similar experiences we would be glad to offer them the use of these columns to comment upon them. If it is once established that a 16-inch Allen valve will give as large a proportion of mean effective pressure as does a larger valve, either plain or with the Allen port, the advantage of the smaller valve in service will be very great as there must be a material reduction of the valve seat friction. This will not only reduce the loss of power but will also reduce the springing of the valve gear and insure the proper port opening.

Master Car and Locomotive Painters' Association.

The twenty-eighth annual meeting of the Master Car and Locomotive Painters' Association was held at the Hygeia Hotel, Old Point Comfort, Va., Sept. 8–10, 1897.

There was a large attendance of delegates and all the sessions of the meeting were well attended. Forty new members were received.

After receiving the address of the President, C. E. Copp (B. & M. R. R.), and the report of the Secretary and Treasurer, Robert McKeon (Erie R. R.), the reading and discussion of papers was taken up.

The first report was on "Protective Paints for Metals. Parts of Cars and Trucks." Mr. J. H Pitard (M. & O. R. R.), a member of the committee, in writing upon this subject, said that there are no anti-rust paints; the virtue of the protective coverings rests entirely with the binding material, and in which case the oil or varnish that is non-porous and forms the most impervious coating, in order to thoroughly exclude the moisture and atmosphere will prove the most effective covering for metal. The question of a pigment is a secondary consideration and while the preference is accorded those that are of a low specific gravity and are by nature not susceptible to atmospheric influences, some of which (such, for instance, as graphite, which does not absorb the oil or binding material), while it is doubtless better for some purposes, such, for instance, as the finishing coat. He thought that some pigment, such as a mineral paint, that does absorb oil, would be preferable as a primer, as in that case the drying is greatly facilitated, which is an essential condition for durability. And yet one stubborn fact remains, which science has failed to remove and that is, that since there are no anti-rust paints, the rust and mill scale must first be removed before painting, otherwise the result will be unsatisfactory. A mere brushing of the surface with wire brushes will not suffice, but every particle of rust must first be extracted from the pores of the metal before painting, or bad results are sure to follow. Therefore, with the aid of the foregoing facts, coupled with practical experience in dealing with rust and scale, which constituting the basis of the metal-painting problem, he believed that good absorbent mineral pigment mixed with pure boiled oil for a primer, and a non-absorbent and unchangeable pigment, such as graphite, mixed with equal parts of raw linseed oil and boiled oil, would constitute a protective covering for metal which, for use under such circumstances that usually obtain in general practice, would produce results as satisfactory as reasonably could be expected.

In view of the fact that this question had been referred to the Association for consideration and report by the Master Car Builders' Association, a thorough discussion of the papers read ensued.

Mr. Ball (P. R. R.) referred to a severe exposure of samples, extending over 15 months, the samples used being red lead, small amount of litharge and raw linseed oil; another sample, straight red lead and linseed oil, without drier; another, red lead and one-half lamp black; another, red lead and three-quarters lamp black; another, mineral metallic paint, red oxide of iron; and last sample, graphite, called Mexican graphite. All except the first were mixed simply with raw linseed oil without any drier. After the exposure the red lead and litharge coating had given way in two or three spots; the red lead was intact and good for several years. The mixture of half red lead and half lamp black had several places scaled off, showing rust. The red lead and three parts lamp black was in still worse condition. The oxide of iron was completely gone. The graphite was perfect.

Mr. Fritz (B. & O. S. W.) painted last year two samples with graphite and red lead, and they are now as good as when painted.

A long discussion was held as to whether the pigment, or the vehicle with which it is mixed, is the life of the paint, and it was the almost unanimous conclusion that the vehicle is the life of the paint.

Mr. Gohen, to conclude the discussion, moved that it is the sense of this Association that any first class pigment, mixed with a first-class quality of linseed oil, properly applied and cared for, will answer all purposes for all metallic parts of cars or locomotives, or structural iron, which it is proper to paint with an oil paint. This motion was unanimously adopted.

The next paper was "What methods of surfacing will give fairly good results without the use of either sandpaper or lump pumice stone for passenger cars or locomotive tenders."

In the paper by J. H. Kahler (Erie R. R.) on the next subject, "Painting Railway Equipment with Compressed Air," he said: "A great deal of fault is found in the working of different machines, owing to the spray produced filling the atmosphere with light floating mist through the shop when working indoors, but with a properly constructed device, the paint correctly prepared and sprayed with the proper pressure of air, this trouble is reduced to a minimum. For rough repaired freight cars the spray painting surpasses the brush, as the paint is blown into all bruises and roughness of surface without the usual amount of brushing by the old way. Far better work, with less material, is the result. Paint spraying has proved a success in doing freight cars, by reducing time in shop and cost of brushes; cars can be got into service quicker than by the old way with the brush, which is a gain to the railroad companies when the cars are in demand; it also proves an incentive to paint more cars, owing to the fact of the time out of service is reduced, thereby improving the appearance of the rolling stock."

The next subject, "The Cleaning of Passenger Cars and Engines at Terminals," excited much earnest discussion. Mr. Thomas Byrne (C. & O. R. R.), said "For cleaning our passenger equipment at the Richmond terminal we use a force of 20 employees, eight of whom look after the inside and 12 after the outside of the cars. They also ice and water the cars, cleaning all brass work inside and out, attend to the bedding and all interior fittings of the Pullman sleepers stopping there, and are required to keep the premises or coach yard clean and presentable at all times. We clean on an average 24 cars per day. Of these only four are cleaned daily with an oil soap which we use; the others are carefully wiped off with clean cotton waste, and present usually a very neat appearance, and then the next day four of those that were wiped on a preceding day are cleaned with the oil soap, and this is continued alternately so that at all times our equipment is looking fairly well. I have found that the best person to manage the cleaners and look after the condition of the cars is a good practical painter, one who feels a pride in his business, and is capable of managing. Another very important adjunct in the cleaning of cars at this terminal is compressed air, which we use on the interior of our cars, and find it wonderfully effective. We also use the oil soap sparingly to brighten up and renovate the headings and other interior wood work, and when carefully done it is a decided improvement upon the ancient system of dusting and wiping. The oil soap which we use is a manufactured article and is applied with a thoroughly saturated piece of cotton waste. The work to which it is applied is fairly well rubbed and is immediately wiped off with a clean piece of cotton waste, care being taken at all times to remove all traces of the soap. If properly done all stains, accumulations of smoke and other imperfections, are removed from the body of the car, leaving it as though it had just come out of the paint shop. Our engines and tenders are treated in the same manner as the passenger equipment, but not so frequently."

In the discussion Mr. Byrne stated that average cost of cleaning each car was $1.20.

Mr. Cohen offered the following:

Resolved—That it is the sense of this Association that it would be economy for all railroads to regularly and thoroughly clean all its passenger equipment, cars and locomotives, at stated intervals, with some good neutral cleaner, other than soap and water, and that this cleaning be put under the immediate supervision of the master painter of the road. Unanimously adopted.

In the paper on the "Best Method of Painting a Canvas Roof," Mr. H. L. Libby (West End Ry., Boston), said in part: "It is claimed by many that linseed oil has a tendency to rot the canvas, and that it should be well sized before the oil is applied. Possibly this is so, but it has been my practice to have the canvas set in a thick bedding composed of two-thirds lead to one-third whiting, thus forming a cement which unites the canvas so closely to the roof boards as to become part of the same. We then prime the outside or top with an oil and lead primer. Thus we have the lead before it and lead behind it, and any decay that may take place, so far as the canvas is concerned, can do but little harm. After allowing the canvas to set as long as possible and priming to harden we continue with the lead and oil."

Among the other papers presented were the following: "The Repainting of Damaged Foreign Freight Cars." "How Can the Elementary Rate-Fixing be Best Attained for Use in Establishing Piecework Prices in the Railway Paint Shop?" "The Railway Paint Shop of Modern Times." "Is it Advisable to Rub to a Dead Finish the Interior of Passenger Cars?" "What is the Extra Cost?" "The Relations that Should Exist Between the Master Painter and His Superior." In addition to the foregoing there were a number of topical questions of a practical nature.

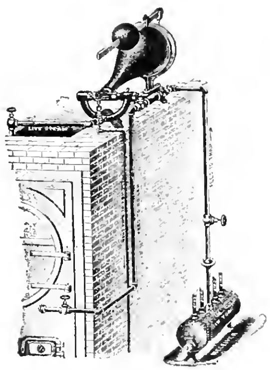
The following are the newly-elected officers: President, Charles E. Copp (B. & M. R. R.); First Vice-President, H. G. McMasters (Ill. Cent.); Second Vice-President, J. T. McCracken (Jackson & Sharp Co.); Secretary and Treasurer, Robert McKeon (Erie R. R.). The vote for the next meeting place was: St. Paul, 41; Montreal, 40.

The following supply houses were represented at the meeting: Moses Bigelow & Company, Newark, N. J.; Berry Brothers, Baltimore; Chicago Varnish Company, Chicago; Chandler & Company, New York; Chilton Manufacturing Company, New York; Detroit White Lead Works, Detroit; F. W. Devoe & C. T. Reynolds Company, New York; William Harland & Son, New York; Hildreth Varnish Company, New York; N. Z. Graves & Company, Philadelphia; J. L. McCloskey & Company, Philadelphia; Murphy Varnish Company, Newark; Patterson-Sargeant Company, Cleveland; Thresher & Company, Dayton; Valentine & Company, New York; Robert Ingham Clark & Company, New York; Valentine & Company, New York.

The Bundy Return Steam Trap.

Last month we presented an illustrated description of the Bundy gravity pump, as manufactured by the A. A. Griffing Iron Co., 66 Center street, New York. The return steam trap, which is illustrated herewith, which is manufactured by this firm, practically fulfills the duties of a pump and is more convenient for use under certain conditions than a pump. When a feed-water heater is used, which is connected with the city mains, the water from the heater may be passed into the Bundy return trap and then into the boiler. When the trap is used in this way it is necessary to employ a heater in order to heat the water so as to be handled by the trap. If it is at a temperature of 100 degrees or over the trap will put it into the boiler without difficulty, and the combination of an exhaust steam feed-water heater and a trap of this kind is a very economical one. In addition to the boiler feeding the trap will return the condensation water from drying coils or steam separators.

This trap depends on the weight of water for its operation. The water accumulates in the pear-shaped bowl, shown in the engraving, and when this is filled it settles in the frame and



The Bundy Return Steam Trap.

opens the steam valve to admit boiler steam to the trap. This closes the check valve through which the water came to the trap and equalizes the steam pressure on the trap and the boiler, whereupon the water passes into the boiler by gravity. After the discharge of the water the lightened bowl rises in the frame, closes the steam valve and opens the air valve, so that the water will again fill the bowl. The trap is open to the atmosphere while filling, which hastens the operation. The discharge of water into the boiler is from three to fifteen gallons per operation, and it is said to be as positive in its action as a pump and no expense is required for steam to operate it, beyond the amount necessary to fill the bowl of the trap, and this is condensed when the water flows into the trap, so that there is little loss of heat in its operation.

The manufacturers express wonder that a great many people do not appreciate the amount of saving that may be effected by the use of these devices. From reports received from persons using them it is clear that the subject is worthy of investigation by steam users. These manufacturers also furnish tank traps, which may be used for discharging water into a tank or sewer. The simplicity of construction of the Bundy trap is one of its best features. It is entirely free from ball floats and other mechanical complications.

Test of Riveted Joints.

The strength of riveted joints is a thing which is usually calculated, and the maximum strain which a boiler shell will stand is based upon the result of such calculation, according as the joint is of one form or another. Nothing of the kind is so conclusive, however, as actual test of the joint and a determination of the ultimate breaking strain. The results of some recent tests at the Watertown Arsenal, made for Edward Kendall & Sons, are therefore of interest.

The tests were all made on steel plate nominally $\frac{1}{2}$ inch thick, and all the rivets used were $\frac{7}{8}$ inch diameter, with $\frac{15}{16}$ inch drilled holes. The ordinary double-riveted joint 13.5 inches wide, with rivets pitched $3\frac{1}{4}$ inches apart, broke when the strain was 47 per cent. of the tensile strength of the solid plate. A butt joint with double covering plates, one $10\frac{7}{8}$ inches wide and one $5\frac{1}{4}$ inches wide, with the two rows of through rivets pitched $3\frac{5}{8}$ inches, and the outer rows twice this distance, gave an efficiency of 57 per cent. This joint was 27 inches wide. A similar butt joint with the lower covering plate $15\frac{1}{2}$ inches wide, and containing four rows of rivets, the two rows of through rivets being spaced $2\frac{1}{2}$ inches apart, showed an efficiency of 78 per cent., the plate containing the joint in this case being 20 inches wide. The lengthening of the covering plates and introduction of two more rows of through rivets increased the efficiency only 0 6 per cent.

In another series of tests made with the ordinary form of triple-riveted butt joints, having one covering plate 10 inches wide and one 15.5 inches wide, the joint broke with a strain of 80 per cent. of the strength of the solid plate when the rivets were pitched $3\frac{5}{8}$ inches, and with a strain of 83 per cent. when the pitch was $2\frac{1}{2}$ inches. When the lower strap was lengthened to 22 inches to receive two extra rows of rivets, and the joint was tested at a temperature of 410 deg. Fahr., the efficiency was 90 per cent. on one trial and 85 per cent. on another. The rivets were pitched in these cases $2\frac{1}{2}$ inches. When the same arrangement was tried with a pitch of $3\frac{5}{8}$ inches, the efficiency dropped to 82.5 per cent.

These trials show that the finer pitch secures the stronger joint, and that, in either case, the triple riveted butt joint, having double covering plates, can be made to give an efficiency of 80 to 85 per cent.—*Engineering Record.*

Locomotive Operation.*

How should a locomotive be operated to secure the most economical use of steam and fuel, speed and weight of train to be considered? In this question exist a great many points, as every act pertaining to the merits or demerits of the engineman all leads either to the economical or extravagant use of steam and fuel.

That we may have the many points more clearly in mind, let us include them all in these three great heads:

First—The skillful manipulation of the different valves and levers that serve to control this force, that it may be used to its utmost capacity when necessary, and its power also be tempered when the conditions so demand.

Second—Skillful firing.

Third—Education of enginemen.

In this subject generally occurs great diversity of opinion between theoretical and practical enginemen. For instance, from a theoretical standpoint, a locomotive, under all conditions, should be worked at shortest possible cut-off with wide-open throttle, thereby saving heat and fuel by working the steam to its fullest expansive force. However, practice has taught the engineer that this rule does not hold under all conditions; that it is not always the most economical method, where speed and weight of train are to be considered. The fact is apparent to every practical engineman that he saves a certain amount of heat by manipulating his machine in conformity with the conditions relative to speed and weight of train. Regarding the loss of power and heat by working too expansively, we can say that the loss of power has been greatly obviated by the use of the balance slide valve, but the loss of heat from condensation, by increasing the ratio of expansion beyond a certain limit, is enormous, and to overcome this loss is a problem which seems to fail of solution, except by compound expansion and skillful manipulation of the throttle and reverse lever. It is plain that any imperative rule tending to interfere with the engineman in regard to working his engine under all conditions would be expensive and injurious to the service.

If the time is fast the throttle should be opened wide when starting, but if the time is sufficient to warrant, the speed should be regulated with reverse lever, and be hooked up in accordance with speed and weight of train. At this point the engineer cannot be governed by any fixed rule, but should exercise his judgment, and not cut the lever back so far that, to use an engineman's term,

* From a committee report presented to the Traveling Engineers' Association.

"The engine will work against herself." "Working against herself" occurs when the engine ceases to maintain her speed in proportion to length of cut-off and throttle, thereby causing back pressure produced by condensation and re-evaporation. This, according to the old rule, is where working expansively is working expensively. Care should be taken not to force the engine into speed faster than necessary to make schedule time, by giving due consideration to schedule, and by making the speed as uniform as possible, avoiding an unnecessary increase of speed for the purpose of making up time before it is lost. For the well-known fact that speed increases expense is very perceptible on the coal record and comparison sheet when the expense is caus d unnecessarily by bad judgment.

As the boiler is the great reservoir, the carrying of water depends greatly on its construction. The style of boiler that has the greatest capacity and will carry water highest when the engine is working at its fullest capacity is, from an economical standpoint, the most advantageous. Why? The larger the body of water being carried the less sensitive pressure will be the feed water and the greater advantage may be taken by the engineer to favor the fireman in cases of emergency. Your committee would here state that these emergency cases are of frequent occurrence to the sagacious engineer, for no matter how skillful the fireman may be, he often spoils his fire for a short period by applying coal too heavily in some part of the firebox. When this occurs the engineer, by having a large body of water, may close the injector for a few seconds, allowing the fireman to recover from the demoralizing effect, and thus regain his confidence, when otherwise he would become excited and continue to get his fire in a worse condition. The boiler being the storehouse for heat, the engineer should take advantage of every opportunity to store the heat therein, instead of allowing it to escape to the atmosphere through the safety valve. How often a fireman has been heard to remark that he could keep plenty of steam for some particular engineer, while on the same engine with some other engineer he found it difficult to make steam enough to get over the road. Where such cases as this exist it is the opinion of your committee that they are due to the carelessness or incompetency of the engineer. The first-mentioned engineer, by taking advantage of the opportunity to keep the boiler full of water when standing on the siding or at stations, stores away thousands of units of heat that he may draw from by leaving the injector closed at the start, when the engine is laboring into speed, thereby giving the fire a chance to recover from the effect of closed dampers during the stop. The careless, or second-mentioned engineer, pays no attention to the water when the engine is standing or switching, except to keep enough in the boiler to insure safety, and when ready to start pulls out with water so low that it is necessary to immediately turn the injector on full in order to keep the water within a safe limit. The fireman, noting this, will at once commence to crowd his fire in order to counteract the great drain on the boiler, and the results are the boiler loses pressure from the effect of a heavy fresh fire, and in almost every instance the fire is spoiled. When the next stop is made, and should it be for any length of time, the fireman not wishing to be caught again with a low fire, will keep it burning furiously, resulting in a wasteful loss of fuel. The engineer should ever bear in mind that upon good pumping depends a great deal more than simply carrying enough water to prevent the burning of the crown sheet.

As a factor of economy the fireman stands equal, if not paramount, among all men in railroad service. It has been said that through his carelessness may occur an enormous loss, while through his judicious handling of the scoop dividends may be paid. To tell a fireman how and when to put the coal into the firebox in order to secure the most perfect combustion would be as impossible as to teach him how to swim by simply telling him how to do it. The art of firing must be acquired by practice and careful study. However, he should be instructed to guard against the many errors into which firemen are liable to fall.

As everything pertaining to the economical management of the locomotive depends on the training of the engineman, the effort should be equally as great in their developments as that used in bringing the locomotive up to its high grade of efficiency. Since the construction of the first locomotive, the most strenuous efforts have been made to bring it to the highest state of perfection. As to the results that have been attained the modern locomotive will demonstrate. Only within recent years has any attention been given to the development of the minds of the enginemen to bring them up to a standard corresponding to the engines they operate. Though the man operating the locomotive may be deficient in technology, though he may not have had the advantage of an academic course of training, he will, quoting the words of one of our officials who has generously taken an interest in the training and betterment of his men, "naturally turn toward knowledge, as a plant would incline toward the light." The engineman should be given every opportunity and encouragement to study the many good books and periodicals concerning his own work, and other lines, which will serve to broaden and expand his mind, thus making him economical, safe and efficient. In the training of the engineman, care should be taken that his labor be not so arduous as to affect his power of conception, for after a man's mucular powers have been overtaxed and exhausted, he will be incapacitated for any brain work necessary to qualify him a first-class engineman. The human body is only capable of a certain amount of energy, which can be used either in manual labor or developing the brain power; therefore when this energy is overtaxed in the performance of manual labor, it detracts from the energy that should go to brain work. For example, we will take a railroad president; he may be as strong, physically, as any man, but place him at braking on a local freight train for 12 hours a day, and at the end of the first few days you will find him totally exhausted, but should he continue in this capacity for any length of time the muscles that had lain dormant for years would develop and become hardened, so that he would be able to stand the work all right, while the nerve fibers that furnish the brain power would detoriorate from lack of energy in that direction. In a short time the directors would not feel disposed to go to him for information in regard to the management of the road, although they would probably be able to get some good points in unloading way freight. In the construction of all large buildings and machinery, the different parts, before being put in, are given the most rigid inspection, also after the construction is completed it is again inspected, to guard against structural weakness. This method of inspection your committee believes, from an economical standpoint, should apply to the selection of material to operate the locomotives on our railroad systems. In the hiring of men for firemen young men should be chosen who possess the natural qualifications requisite to graduate them into a higher degree. As one of our road foreman of engines, who is known for his broad and liberal views, has expressed it, "In order to handle an engine successfully it would be necessary to begin at least one generation before the engineman is born."

Petroleum Steam Engine Fuel.*

BY J. A. F. ASPINALL.

Petroleum as liquid fuel has been used much more largely than other oils, but gas tar, creosote oil, and green oil from gasworks have also been found to be very effective. The first experiments in Russia with petroleum were made in 1874, but it was not until 1883 that liquid fuel was used to any great extent in locomotives. Many experiments were tried in the direction of using atomizers or pulverizers for the purpose of making liquid fuel into the form of a spray, and among them may be mentioned those of Lentz, Artimeff, and Brandt. In 1884 a communication as to the use of liquid fuel for locomotives in Southeast Russia was made by Mr. T. Urquhart to the Institution of Mechanical Engineers, and that communication contains very full information as to the way in which the work was done.

While there is little doubt that there are great advantages in the use of petroleum refuse for raising steam, either in locomotive or other boilers, in a country like southeast Russia, where such fuel can easily be obtained, the difficulty of obtaining it at a reasonable price in this country has been a barrier to the introduction of liquid fuel as an article of considerable consumption, although its great convenience and adaptability render it a very desirable fuel if anything can be done in the way of insuring a constant supply at a moderate price. Roughly speaking, the author has found that with Lancashire coal at 9s. per ton, liquid fuel ought not to cost more than 1d. per gallon to do equivalent work. In the south of England, where coal is dearer, the conditions are somewhat more in favor of oil. The use of oil is in some respects not unlike the use of gas in a gas stove, as it can be turned off at once when it is not wanted, and started again at a moment's notice, thus preventing waste. The combustion can be made so perfect as to get rid of all smoke, and, if proper precautions are taken, no damage whatever is inflicted upon the firebox plates. These, no doubt, have to be protected in some instances by a lining of brickwork where the spray impinges upon one spot constantly, but, on the other hand, the firebox sides in a locomotive are relieved from the constant abrasion of the coal, which tends to wear down the plates between the stays and thus reduces the life of the firebox.

A liquid fuel system does not necessitate the radical alteration of a boiler, as in most cases arrangements can be made: 1st, either to

*A paper read before the Institution of Civil Engineers (England).

burn coal alone; 2d, coal and oil in such proportions as may be convenient, and 3d, oil alone.

The theoretical evaporative value of different kinds of oil compared with coal has been as under:

Theoretical Evaporative Value of Petroleum From and At 212 Degrees Fahr.

	Pounds of water per pound of fuel.
Pennsylvania heavy crude oil	21.48
Caucasian light crude oil	22.79
" heavy " "	20.85
Petroleum refuse	20.53
Good English coal	14.61

The methods of applying the oil jet in a locomotive boiler have been varied a good deal, in some cases the oil being introduced through the firehole door, and in other cases the jet being inserted below the foundation rings; so that, as Mr. T. Urquhart pointed out, he was able, where he burnt nothing but liquid fuel, to close up the firehole door altogether, thus obtaining more heating surface in his firebox.

The method adopted by Mr. Holden on the Great Eastern Railway is to put in two special openings through the firebox casing, into which are entered the oil jets.

The use of liquid fuel has not been confined to locomotives, as so far back as 1886 the Russian Government tried experiments upon two steamers built by Butz & Company, St. Petersburg, and fitted these with a type of furnace invented by Lieutenant Pashinin, and in that case it was stated that the petroleum evaporated 2½ times as much water as the coal which they had at their disposal. Messrs. William Doxford & Sons, of Sunderland, also experimented with a torpedo boat fitted with a petroleum fuel arrangement, and there are numerous instances of recent applications. Where boilers are hand fired, or in the case of vessels in a heavy sea, it is found that the amount of labor involved can be materially reduced by the use of liquid as compared with solid fuel, and taking into account the higher evaporative efficiency of oil, there may be occasions upon which, where oil is available as fuel, a smaller boiler may be introduced with advantage, thus saving weight in vessels of the torpedo boat class. There have been instances in which oil has been used in electric light stations where sudden demands, due to fog and other causes, have made it difficult for the existing boiler plant to produce steam rapidly enough during the period of maximum output, whereas the existence of an auxiliary oil-burning plant has enabled the boilers to get through the short period of hard work without the slightest difficulty.

The most conspicuous application of oil burning in this country is that on the Great Eastern Railway, as perfected by Mr. James Holden. For such particulars as are given of work done upon that railway the author is indebted to Mr. Holden. There are on the Great Eastern Railway 37 locomotives, 13 stationary boilers, and four furnaces fitted with liquid fuel firing at present. In the case of the locomotives, the oil fuel is carried in two cylindrical tanks placed on the tender, leaving the central space perfectly free to hold coal as before. Suitable provision is made for warming the oil in these tanks in the winter. From these tanks the oil is carried by pipes to the engine foot-plate, where, after passing through the necessary valves, it is sprayed into the firebox by the injectors.

An ingenious addition to this form of injector has a pipe at the end through which heated air, heated by the waste heat in the smokebox, can be drawn through the injector, which it enters at a temperature of 300 degrees Fahr., combining with the oil as it enters the firebox. Another use which is made of this induced current where a locomotive happens to be fitted with the automatic vacuum brake is to couple the injector up with the brake pipes and make the fuel injector act as an injector for maintaining the vacuum throughout the train. Where this is done, of course, the advantage of the heated air going into the firebox is not obtained. Should oil fuel be used alone, it is only necessary to cover the firebars with a thin coating of broken firebrick so as to prevent the inrush of too much cold air.

The consumption of fuel for doing corresponding work is stated to be on the Great Eastern Railway as follows:

			Pounds per mile.
When using coal only			35.4
" " " and oil combined	Coal	11.8	
	Oil	10.5	
			22 3
" " " oil only			16.5

Once the use of oil is arranged for in considerable quantities it becomes an easier matter to supply the locomotives with their fuel than in the case of coal, as the oil can be allowed to run out of suitable tanks with great facility into the reservoirs provided upon the tender. The fuel employed on the Great Eastern Railway until recently consisted of Russian astatki, or petroleum refuse, having a specific gravity of 0.906 and an ignition temperature of 336 degrees Fahr., but the quantity imported to this country is not sufficient at present to make it readily obtainable. At present green oil is being used, and this is obtained from gas works, and has a specific gravity of 1.1 and a flash point of about 220 degrees Fahr.

The author has fitted several Lancashire & Yorkshire Railway Company's locomotives with oil-burning apparatus for use on the Liverpool Dock lines, the main object in this case being, not to economize in fuel, but to get rid of fire risk, on account of the emission of sparks, and also to avoid the production of smoke, which would have been most objectionable in passing some of the Liverpool streets. In this case Holden's injector was used, and the author has reason to believe that this course has been followed by the other railway companies who make use of the Liverpool Dock lines. In the case of the Liverpool engines, creosote oil has been largely used as being the cheapest fuel available, but gas tar has been found to give very good results.

The use of liquid fuel for the production of steam cannot be said to be in any way in the experimental stage so far as mechanical appliances are concerned; in fact, it may be called an ideal method of raising steam, the only difficulty arising being that of the question of supplying fuel at a reasonable price, a difficulty not easily surmounted in a country so far removed from the oil fields.

"Third Rail" Insulation.

A correspondent sends us the following with regard to the leakage from the "third rail" of a surface road application of electric traction:

When the N. Y., N. H. & H. R. R. first took up the third rail conductor system to replace the overhead trolley, the electrician in charge consulted a large number of electricians with varying results; most of these experts said there would be an enormous waste of current by radiation and conduction from the third rail, which has a voltage of 600. The system was tried, however, and actual tests gave the following results:

The line consisted of seven miles of third rail conductor, a return through the T-head service rails, two miles of copper cable from the power house to the track, with all joints copper bonded. At the first test trouble was experienced from leakage. The test was made after a storm, while the ground was wet and conditions very unfavorable, and a leakage of 2.6 amperes was discovered. It was afterward found that the truckmen had driven a spike through the white metal cable covering, and thus destroyed the insulation. The wires were found melted through, amounting to one-third the section of the cable. The second test was made on a dry evening with favorable conditions, and a circuit leakage of 0.5 amperes was found. The third test was made while the track was flooded with water for a distance of about two miles, though the motor cars continued their regular trips and no inconvenience was experienced at the station. A trolley street line took its current from the end of the third-rail conductor, and continued at its regular speed notwithstanding the fact that the third-rail was connected with the return circuit through the service rail by a water bond. The fact is that the conductors are so large and the resistance so small that there is no inducement for the current to leave the rail for a poorer conductor.

The Vibration of European Railway Carriages.

A number of tests have been made by the author to investigate the causes of vibrations of railway carriages while traveling. The carriages placed under observation were those of the Austro-Hungarian State Railway Company used in express trains of first and second class, with two axles, and with an average weight of 11.4 and 11.8 tons, and wheel base of 16 feet and 16.7 feet respectively.

The vibrations caused by defects in the permanent way or by loose coupling, being local disturbances, were not considered, and the observations were confined to carriages running on a well-kept road, properly coupled, uninfluenced by neighboring carriages, and situated in the center of the train.

The vibrations are classed in two divisions, namely:

1. Vibrations, chiefly perpendicular, which produce a quivering of the flooring and shaking of the partitions.
2. Vibrations in the transverse direction.

The vibrations in the first division are always short and quick, at the rate of about 300 per minute, become perceptible at a certain speed, and rapidly increase with the speed, and are not affected by curves. The vibrations in the second division are irregular, appearing at unequal intervals and with varying force, or they appear as more or less continuous swingings of the carriage around the perpendicular middle axis. They appear mainly on straight portions of the line, and decrease steadily on curves.

The cause of the vibrations produced under (1) is always the eccentrical position of the center of gravity of the wheel. Experiments were made, and it was found that if perpendicular suspension of the springs is employed, the main cause of these vibrations is avoided, and there is only a slight vibration in the direction of the journey.

The main cause of the vibrations produced under (2) is to be found in the usual method of fixing and suspending the springs for two and three axled carriages. In this method one portion of each spring is fixed on the axle box, the other portion through the suspension hangings to the carriage frame. The perpendicular thrusts are indeed weakened, but the horizonal side workings are very little weakened in the course of transmission through the springs. These vibrations are to a great extent overcome by the use of cross-springs, as in the case of bogie frames. The condition of the car-

riage in regard to the state of wear of its constituent parts has a very considerable influence on the vibrations in the second division, the principal causes being the following:

(*a*) Defective conditions and tension of the springs. The springs hould be so flexible that they are able to transmit the sudden thrusts in long, gentle swingings, and cause a continuous easy motion of the carriage. The corresponding springs on the same axle should be perfectly similar, and all the springs of the same carriage should be built out of the same materials.

(*b*) Faulty condition and bearing of the spring supports.

(*c*) The non-existence of a sufficient conical surface on the wheel tires, always giving rise to pendulum-like vibrations.

(*d*) Unequally high buffer springs on the same side of a carriage, and an unequal amount of shrinkage in the buffer box.

(*e*) Side play of the axle journals, and play of the buffer rods.

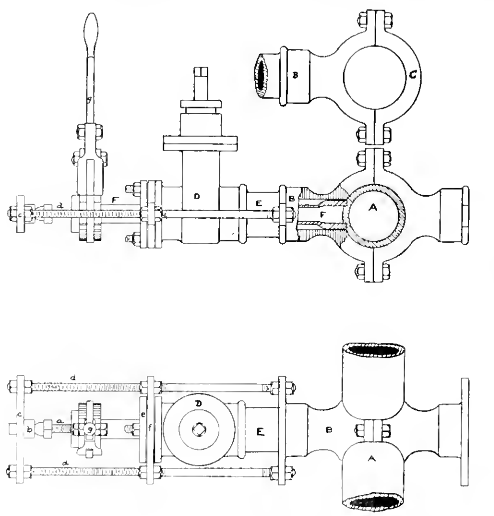
It is of great importance to find out the correct time when a carriage should be sent into the shops to undergo repair and adjustment, and although this is usually fixed by the mileage run, the author states that it is not a fair criterion to judge by, and the time should be fixed by some means of measuring the vibrations.

The author gives a detailed account of a number of experiments he made with wheels with varying counterweights in varying positions, and of the method of finding the counterweights necessary for compensating the eccentrical position of the center of gravity of the wheels, and states that the vibrations produced under (1) can be removed by the use of counterweights.—*Inst. C. E. Foreign Abstracts.*

Curran's Pipe Tapping Device.

The accompanying illustration shows the construction of a device for tapping water mains without interfering with the current therein or causing leakage during or after the operation. The engraving shows a side view partly sectioned, a plan and a portion of a modification of the device.

A represents the water-main, and *B* the branch nozzle, provided with a curved flange to fit around the main. The extremi-



Curran's Pipe Tapping Device.

ties of the flange are connected by bolts to a correspondingly curved strap, *C*, on the opposite side of the main, and a water-tight joint is formed between the flange and main. *D* is a stop-valve attached directly to the nozzie *B*, or indirectly by means of a pipe *E*, as shown in the drawing. In the two principal views the strap *C* is dispensed with, and two nozzles are used, the flanges of which are bolted together, forming a complete circle around the main *A*. *F* is a hollow-boring bar, one end of which is enlarged to the size of the proposed aperture in the wall of the main, and serrated or toothed to form a cutting edge. The other end of the boring-bar is fitted with a feed screw, *a*, pointed to rest within a center, *b*, in the cross-bar *c*. The cross-bar *c* is held by means of the rod, *d*, which extend to lugs projecting from the nozzle *B*. The boring-bar, where it enters the stop-valve, is packed in order to prevent leakage around it, the packing being secured from accidental removal by means of the gland *e* and flange *f*. The boring-bar is operated through the medium of a ratchet-lever *g*.

The operation of attaching a nozzle to a water-main, and of boring the communicating aperture between them, in a manner to prevent leakage, is as follows: The nozzle, with the stop-valve, being placed in the desired position, and the strap *C* bolted thereto, the joint is formed by pouring molten lead between the surfaces of the nozzle-flange and the main. The rods *d* and the packing devices are then adjusted, and, the valve proper being raised, the boring-bar is inserted in the stop-valve, the cutting end being brought into contact with the outside of the main, and the feed-screw *a* resting within the center *b* in the crossbar *c*. An annular groove is then cut in the outside of the main. Upon the penetration of the boring-bar entirely through the side of the main, the bar is withdrawn sufficiently to allow of the closing of the valve, after which the bar may be entirely removed.

The circular piece of metal cut from the side of the main is withdrawn with the boring-bar, as it is retained within the bar by the pressure of the water in the main. It will be seen that the tool employed, not having a center point, immediately begins its cut, and does not weaken the piece removed and cause leakage from the main before the metal is entirely penetrated by the drill proper. The connection of the branch with the valve and rear bar *c*, by means of the screw-rods *d*, gives great rigidity to the whole and enables the tool to be fed up to the main in a convenient manner.

We are indebted to Mr. H. M. Etchison for the drawing and description.

EQUIPMENT AND MANUFACTURING NOTES.

The Chicago, Milwaukee & St. Paul has ordered two new trains for its Chicago-St. Paul service of the Barney & Smith Company. These trains are to be lighted by electricity and are to be up to date in all respects.

Since the announcement by the Haskell & Barker Car Company, of Michigan City, Ind., that they have orders sufficient to keep them busy for two years, there has been a great deal of speculation as to what orders they have in hand. It is impossible to give the figures, except in the case of the Chicago & Northwestern, which is building 1,000 cars at their works, but, says *The Railway Age*, the suspicion is that the company has contracts with the Northern Pacific and Great Northern roads for 5,000 cars each, making 11,000 cars under contract to be delivered within two years. The annual capacity of the Haskell & Barker Works is in the neighborhood of 6,000 finished cars, which would about accommodate the orders spoken of and justifies the bulletin posted.

The works of the Peninsula Car Company at Detroit are reported to have resumed works in all departments, the amount of work now on hand being sufficient to warrant it.

The United States Car Company is building 500 box cars at Anniston, Ala., for the Louisville & Nashville.

The Buffalo Car Manufacturing Company has an order for 100 freight cars from the Buffalo, Rochester & Pittsburgh.

The Ohio Falls Car Company is building 100 freight cars for the Memphis & Charleston and 50 for the Cincinnati, Portsmouth & Virginia.

The Harlan & Hollingsworth Company, of Wilmington, Del., has finished building 200 gondola cars of 60,000 pounds capacity for the Wilmington & Northern. They have "Little Delaware" couplers, Marden brake beams, Westinghouse air-brakes and springs by the Chas. Scott Spring Company.

The Baldwin Locomotive Works have received an order for two heavy Vanclain compound freight engines from the Chicago, Milwaukee & St. Paul. They will also build one locomotive for the Rumford Falls & Rangeley Lakes Railroad and one for the Georgia Pine Railroad in Georgia. Other orders have been received as follows: One engine for the Mobile & Birmingham, seven 10-wheel engines for the Houston, East & West Texas, two 6-wheel 60-ton switch engines for the Kansas City & Belt, four for the island of Formosa and three more for the Canadian Pacific.

The Schenectady Locomotive Works has received orders for building locomotives as follows: Ten engines for the Imperial Government Railways of Japan, two eight-wheel passenger engines for the Texas Midland.

The Pittsburgh Locomotive Works will build five freight locomotives for the Chicago & Eastern Illinois.

The Cooke Locomotive Machine Company has orders for two consolidation engines for the Oregon Short Line, and for rebuilding an 8-wheel passenger engine and changing it to the two-cylinder compound type for the Erie. This engine is to have a Wooten boiler.

The Richmond Locomotive Works have received an order for 12 consolidation engines for the Chesapeake & Ohio and one for five consolidation compound engines for the South Carolina & Georgia.

The Brooks Locomotive Works have taken an order for 20 locomotives for the Imperial Government Railways of Japan, and are now building two mogul engines for the Jalapa & Cordova Railway and one for the Climax Manufacturing Company, of Corry, Pa.

The Chicago Railway Equipment Co., of Chicago, Ill., makers of the National hollow brake beam, shipped 200 brake beams on the steamer "Columbia" from Tacoma, Wash., on Sept. 1, for the Chinese Imperial Railway.

Mr. Stephen D. Barnett has been appointed Agent for the Kalamazoo Railroad, Velocipede and Car Company in the East, with office in New York.

The Page Woven Wire Fence Company has recently improved its fencing by providing a rigid connection between the two top bars. The object of this is to prevent the appearance of sagging after persons have climbed over the fence. The addition was not needed for strength, but for appearance.

The Edward P. Allis Company, Milwaukee, has sold a 200 horse-power Corliss engine to the Chicago, Rock Island & Pacific. It has been installed and is furnishing power for the car department.

The Union Passenger Station at St. Paul will be enlarged.

The Long Island Railroad has fitted up a hospital car for use on its lines in case of accident.

Wages on the Lehigh & Hudson River that were cut last year have been advanced 5 per cent.

The Priest locomotive flanger, designed by Mr. A. F. Priest, has passed into the control of the Q & C Company, of Chicago, who will manufacture and sell it.

The Southern Pacific has apparently gone into the burning of oil for its locomotives "to stay." It is reported that seven locomotives have just been equipped with oil-burning devices.

The controlling interest in the Gibbs Electric Company, of Milwaukee, Wis., has changed hands. It has been formally announced that the Westinghouse Electric and Manufacturing Company, of Pittsburgh, Pa., has bought out the interest of the Gibbs Electric Company. The consideration is reported to be $50,000.

The "Compo" brakeshoe has been improved by the manufacturers, the Composite Brake Shoe Company, of Boston, in a new pattern known as "Pattern C," by the use of "shearing edges," designed to more effectively dress that portion of the wheel tire that does not come in contact with the rail. This improvement seems to be meeting with a very favorable reception.

Mr. E. Tremlett Carter, a well-known English electrical engineer, recently inspected the electrical equipment of the Baltimore & Ohio at Baltimore, as the London Underground Railway has adopted the style of motors that the Baltimore & Ohio uses in the Baltimore tunnel. At the conclusion of his inspection Mr. Carter said that is was the most complete and economically handled plant he had ever seen, and that he had never been in a tunnel that was absolutely free from smoke.

Among the roads having recently increased the working hours in its shops is the Delaware, Lackawanna & Western, which has put its Scranton shops on 10 hours per day and runs full time for the first time in eight months.

The Chicago Grain Door Company reports the following applications of its specialties: The Chicago rabbeted grain door and security lock bracket will be used in the construction of 500 Soo Line box cars building by Wells and French and 500 Canadian Pacific cars building by the Michigan Peninsula Car Company. The grain doors are to be used in building 1,000 cars for the Big Four and 1,000 cars for the C. & O. by the Pullman Company. These doors and brackets were specified for these cars and they have already been ordered from the manufacturers.

An office has been opened by the Ryan-McDonald Manufacturing Company at 78-80 Broad street, New York, in charge of Mr. N. B. Porter. The main office of the company is at 41 South srteet, Baltimore, Md. The orders for dump and flat cars, light locomotives and hoisting machinery are coming in in a very satisfactory manner, and the opening of the New York office is expected to greatly improve the business of the company. The officers report a promising outlook for business.

The Pittsburgh Testing Laboratory, Limited, Pittsburgh, has been commissioned by Major B. M. Harrod, Chief Engineer, to inspect the machinery and steel used in connection with the work of the Drainage Commission of New Orleans, La. This includes the inspection of the compound condensing engines and the centrifugal and screw pumps to be built by the E. P. Allis Company, Milwaukee, the Babcock & Wilcox boilers, the generators and motors to be furnished by the General Electric Company, and 1,500 tons of rolled steel at the Homestead Works of the Carnegie Steel Company, Limited. The Pittsburgh Testing Laboratory also inspected the steel and machinery used at the Controlling Works of the Chicago Drainage Canal near Lockport.

The B. & O. is engaged in the laying of between 300 and 400 miles of new 85-pound steel rail. This work involves a large amount of track supplies, and a communication from an officer of the company calls attention to the number of elements required. These figures are not new, but they show what track renewals mean. It takes 133.57 tons of 85-pound rail for one mile of track. Ties are laid 24 inches from center to center, making 2,640 per mile. Four spikes per tie call for 30 kegs, or 10,800 spikes weighing 6,000 pounds, or three tons. In each mile of 30-foot rail are 352 complete joints, requiring 704 splice bars and 1,408 bolts. The B. & O. uses what is known as the "Continuous Rail Joint Splice Bar," which is supposed to prevent low joints, the bane of a trackman's life.

The Miller-Knoblock Company, South Bend, Ind., announces in a recent communication that an increase in its business is to be undertaken. An electrical department is to be added under the direction of Mr. A. W. Morrell, an electrical engineer and constructor who has had years of experience in street railway motor work. It is the intention of the company to manufacture and carry in stock, ready to ship at a moment's notice, Morrell's improved assembled motor commutators for electric power motors. The fact that users of motors can procure assembled commutators for all standard motors will be appreciated. The concern will also carry in stock armature coils for all the standard motors. A complete equipment for the rewinding of armatures has been put in.

The Armstrong Manufacturing Company, of Bridgeport, Conn., and 139 Center street, New York, has recently made a number of improvements in their No. "O" Pipe Machine, ¼ to 2 inches, and it is unquestionably the most complete and universally liked tool of its kind on the market to-day. This machine is also built to run by power as well as by hand to suit the work of large shops and mills, and it is reported that the demand for it has been very great the last few months. An illustrated description of it appears on another page.

The erecting and repair shops of the Baltimore & Ohio at Mt. Clare, in the city of Baltimore, have been completely modernized. The locomotive erecting shop has been rebuilt and is supplied with two 50-ton electric cranes which lift the heaviest locomotives and move them to any point. The compressed air appliances are of the latest pattern and the cost of making the improvements will be saved in two years, as the new machinery accelerates the work, which may be done with less expense than formerly.

The use of graphite for brazing is new, and we are informed by the Joseph Dixon Crucible Company, of Jersey City, N. J., that the work of brazing is greatly facilitated by employing this material, which is not affected by acids or alkalies, heat or cold. Braziers who have used it speak well of it. Not a little of the expense in brazing is due to the cost of removing the brass which has stuck to the metal where it is not wanted. The removal of this brass is usually attained only by patience and diligent filing. Graphite comes to the aid of the brazier in this work.

A peculiar case of breaking and entering the factory of the Magnolia Metal Company at Stirling, N. J., on the night of Aug. 6 is brought to our attention. The company referred to caused the arrest of H. G. Torrey, J. Gray Torrey and two others, and caused the issuance of a warrant for Chas. Taylor, all on a serious charge of carrying away tools and other property of the company. The affair has occasioned considerable excitement, and the daily press accounts contain statements to the effect that the object was to injure the business of the company. The Magnolia Metal Company wishes it to be known that none of the parties referred to has any connection with its business. The business relations between the company and H. G. Torrey and J. Gray Torrey were severed on April 15, 1897.

Mr. J. F. Duntley and Mr Joseph Boyer have recently returned from a very successful business trip in England and on the continent. The pneumatic tools of the Chicago Pneumatic Tool Company were brought prominently before the naval architects of several countries by an exhibition at the Imperial Institute in London, many orders, having been taken at this exhibition from foreign governments, and altogether the trip was a very encouraging one. The reception of the pneumatic tools in France where shop wages are as low as 80 and 90 cents per day is the best evidence of their labor-saving possibilities. Mr. Duntley has sold 29 pneumatic tools to such a road. He visited many of the important shops on the continent and says that there are 60 of his pneumatic tools now in use in Russia, 60 in Austria, 40 in Germany, 80 in France and 300 in England. It must be remembered that the efforts up to date have been directed toward getting the machines introduced into railroad shops, and there is a large field yet open to them in other lines as well. It is stated that a company has been organized in England invested with the exclusive right to the sale of the tools in that country. This business is enjoying a remarkable growth from a small beginning and is an example of a good thing energetically pushed.

The Western Railway Equipment Company of St. Louis sends us a report of the sale of its specialties which indicates a very satisfactory condition of its business. The Combination Lug and St. Louis Single Track Flush Car Door have been finished for 1,000 new cars for the Missouri Pacific, for 200 new cars for the Texas Pacific, and 350 new cars for the International & Great Northern. The door referred to has also been applied during the past month to 125 cars of the Illinois Central at the Burnside shops. The Houston Pneumatic Sander, another well-known specialty controlled by this company, has become standard on the Texas Pacific and is being applied to the locomotives of that road at the rate of four per month. The Baldwin Locomotive Works have just applied the sander to three new locomotives for the same road. The New York, Ontario & Western is applying a set of sanders to an engine at the Middletown shops. The Maine Central is putting them upon all locomotives, the San Antonio & Aransas Pass has applied four each month for the past four months, the Atlantic & West Point has placed the sander on two engines, the Kansas City, Ft. Scott & Memphis has put it on six engines at Memphis, and the Pittsburg & Lake Erie has put it on an engine at the McKees' Rocks shops. Among the other roads using the sander are the following: The Missouri Pacific on a new engine of the 999 type—and it will probably be made a standard on that road—the Baltimore & Ohio Southwestern on a locomotive at Washington, the Texas Midland on four new engines building at the Schenectady Locomotive Works, the International and Great Northern on three locomotives during the month of August, the Atchison on two engines at Topeka, the Southern Pacific on three engines, the Kansas City, Memphis & Birmingham on five engines, the Ferro Carril Mexicano del Norte on one engine, the St. Louis Southwestern on all engines at the rate of six per month, and the St. Joe & Grand Island is also using the sander. This list speaks for itself as to the introduction of the device.

Our Directory

OF OFFICIAL CHANGES IN SEPTEMBER.

Baltimore & Ohio.—A. A. Daniels, Master Mechanic, died at Louisville, Ky., Aug 22, at the age of 38 years.

Brainerd & Northern Minnesota—Charles A. Pillsbury has been elected President, and J. E. Carpenter, Vice-President, both with offices at Minneapolis, Minn.

Baltimore & Annapolis.—Mr. Charles A. Coombs has retired from the position of General Manager.

Baltimore, Chesapeake & Atlantic.—Mr. T. A. Joynes has been appointed Purchasing Agent, with headquarters at Baltimore, Md.

Chicago, Peoria & St. Louis.—Mr. F. W. Huidekoper has resigned as President.

Chicago, Peoria & St. Louis.—Mr. W. E. Killen has been appointed Master Mechanic, with headquarters at Springfield, Ill. Mr. W. J. Hemphill, Superintendent of Machinery, has resigned.

Chicago, Rock Island & Pacific.—Mr. Benjamin Brewster, First Vice-President, died, Sept. 4, at the age of 67.

Cincinnati, New Orleans & Texas Pacific.—Mr. Peter H. Schreiber, Division Master Mechanic, died at his home in Chattanooga, Tenn., Sept. 9.

Cleveland, Cincinnati, Chicago & St. Louis.—Mr. H. G. Hudson has been appointed Master Mechanic, with office at Mt. Carmel, Ill.

Cleveland, Cincinnati, Chicago & St. Louis.—Mr. W. P. Orland has been appointed Master Mechanic, with office at Mattoon, Ill., vice G. S. McKee, resigned.

Cleveland, Cincinnati, Chicago & St. Louis.—Mr. R. L. Ettinger has been appointed Mechanical Engineer, with headquarters at Indianapolis, Ind.

Cleveland, Cincinnati, Chicago & St. Louis.—Mr. Mason Rickett has been appointed Master Mechanic, with headquarters at Delaware, O.

Forth Worth & Denver City—Mr. E. W. Hayes been resigned as Superintendent of Motive Power of Machinery, and is succeeded by Mr. George K. Jackson, formerly Foreman of the shops at Wichita Falls, Tex.

Fulton County Narrow Gauge.—Mr D. J. Thayer has been elected Vice-President in addition to his office of Secretary.

Fitchburg.—Mr. W. D. Ewing has resigned his position of General Superintendent; he is succeeded by Mr. C. L. Mayne.

Huntington & Broad Top Mountain.—Mr. Geo. F. Gage has resigned as General Manager, a position which he held for 25 years. Mr. Carl M. Gage succeeds him.

Illinois Central.—Mr. J. S. Chambers has resigned his position of Master Mechanic.

Interoceanic.—Mr. V. Sedgwick has been appointed Locomotive and Car Superintendent, with office at Puebla, Mex.

Iowa Central.—Mr Horace J. Morse was chosen President on Sept. 3 to succeed Mr. Russell Sage, resigned.

Kansas City, Pittsburgh & Gulf.—Mr. Fred Mertsheimer has been appointed Superintendent of Motive Power and Equipment.

Kansas City, Pittsburgh & Gulf.—Mr. David Patterson has been appointed Master Mechanic, with headquarters at Shreveport, La.

Missouri Pacific.—Mr. John S. Thurman has been appointed Mechanical Engineer, with office at St. Louis, Mo.

Norfolk & Western.—James M. Barr, Vice-President, is also General Manager of this road.

Oregon R. R. & Navigation.—Mr. A. L. Mohler has been elected President.

Suffolk & Carolina.—Mr. George L. Barton was elected General Manager at a recent meeting of the Board of Directors.

Sonora.—J. A. Naugle has been appointed General Manager.

St. Louis, Peoria & Northern.—Mr. A. L. Moler has been appointed Master Mechanic, with headquarters at Springfield, Ill.

St. Louis & Hannibal.—Mr. S. Rollins has been appointed General Foreman of the shops at St. Louis.

Texarkana & Fort Smith.—Mr. W. K. Morley has been appointed General Manager, with headquarters at Shreveport, La.

Union Pacific.—Mr. James Roberts has been appointed Master Mechanic of the Kansas division to succeed Mr. Fred Mertsheimer.

Union Pacific.—Mr. Thomas A Davies, Master Mechanic, has changed his headquarters from Laramie, Wyo., to Ogden, Utah.

Wabash.—Mr. Geo. S. McKee has been appointed Master Mechanic, with headquarters at Moberly, Mo.

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

NOVEMBER, 1897.

CONTENTS.

Erecting Shop Mt. Clare—Baltimore & Ohio Railroad.

The erecting and repair shops of the Baltimore & Ohio Railroad at Mt. Clare, in Baltimore, have been completely modernized under the direction of Mr. Harvey Middleton, General Superintendent of Motive Power, and by courtesy of that officer we are enabled to present several illustrations showing the chief features of the new construction. From an examination of the drawings it will be seen that the work was somewhat hampered by the fact that old buildings do not lend themselves readily to modern methods of shop construction. The roof, which is of wood framing, was not sufficiently strong to admit of supporting additional weights, and the walls would not permit of attaching the supports for the rails of traveling cranes. The building is very long, and not being tied across it was considered safer to provide for the sudden shocks that may be brought by the cranes by erecting supports for the cranes that would be independent of the walls. New piers built into old walls would be likely to settle away from the old work, and while the steel posts take up space in the building, they are better than piers would be under the circumstances.

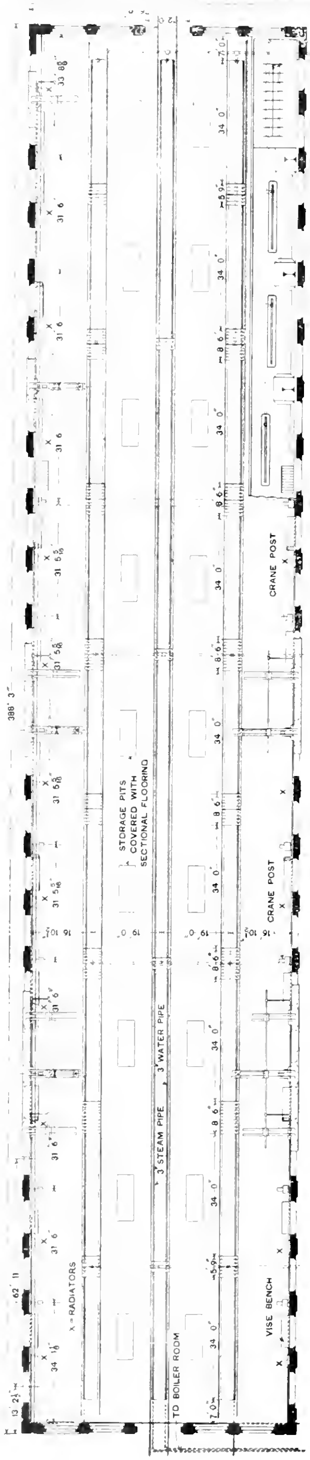
The building is 388 feet long by 76 feet 2 inches wide outside. The inside dimensions are 382 feet 6 inches long at floor line, and 71 feet 9 inches wide. The clear height under the roof trusses is 28 feet 4 inches, and the width is sufficient to admit of a span of 69 feet for the traveling cranes. These cranes are supported on runways placed at an elevation of 15 feet 9 inches above the floor, and the girders forming the runways are 4 feet 1 inch deep. The clearance under the cranes is 20 feet 3 inches. There are two 50-ton electric cranes, built by Wm. Sellers & Company, operated by electricity, and by extending the runways the full length of the building the cranes serve the entire area of the floor. When it is desired to raise or move a locomotive the two cranes are used, as shown in the small sectional view and also in the photograph. The supports for the runways are best shown in the sectional view of the building, which also shows the foundations for the pit tracks. The supports are built upon special foundations placed about 31 feet 6 inches apart, and the lower ends are imbedded in concrete. The spaces between the supports are utilized for vise benches where necessary, these being shown in front of a number of the windows in the plan view.

There are three tracks through the building placed at 19 feet centers. The center track runs out at both ends of the building, and the engines are brought in upon it. They may be stripped on this track and then lifted over upon one of the other tracks by the cranes. When the shop is crowded the center track may be used for work and ordinarily the engines will be finished upon it so as to make room for other engines in the regular work spaces. The photograph shows a 21 by 26-inch 10-wheel engine, weighing 145,200 pounds, as it is being raised by the cranes. This engine has 78-inch driving-wheels and the weight on the truck is 32,200 pounds. The engraving shows the convenience of overhead lifting for such work and Mr. Middleton says that after the pedestal braces, connecting rods and small parts are removed from such an engine preparatory to lifting, but three to eight minutes are required to transfer from the central track to either of the work tracks; the allowance of time between the limits stated is made to cover differences in the amount of labor necessary in freeing the wheels from the spring saddles and equalizer rigging.

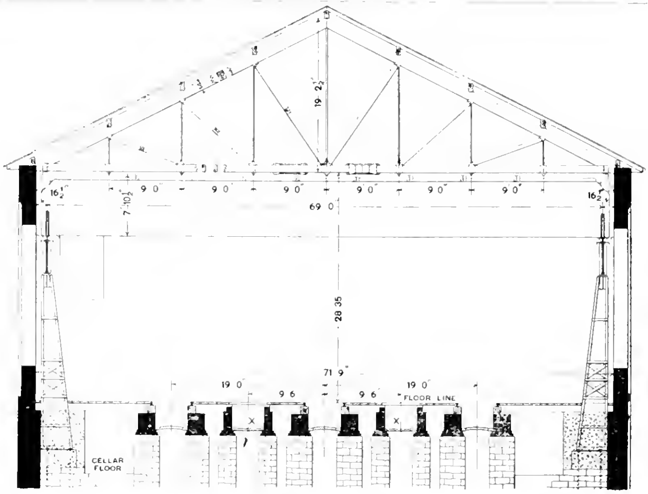
The outside tracks do not extend through the ends of the shop. The pits are built up of concrete on brick foundations, and between the tracks are rectangular storage pits for the disposal of parts of engines, that are undergoing repairs, while the heavy work is being done. These are covered with sectional flooring, and as there are 18 of them considerable storage space is provided in this way. The construction of these will be understood from the views given.

The piping systems are complete and conveniently arranged The heating coils, indicated by X in the drawings, are at the side walls of the shop and are fed from mains of 2½-inch pipe for the left-hand half, reduced to 2-inch for the other half. These mains rest on the roof trusses and there are three expansion loops on each side of the shop. The loops extend along the trusses and the proper slope for the drainage of the mains is obtained by supporting the pipes on blocks of varying thickness. Live steam is used for heating. The return from the coils is made through 1½-inch pipe. The radiator connections to the mains and to the return system are by 1-inch pipe and Jenkins' disk valves of the same size. Expansion in the return pipe is also taken up by loops. The water of condensation runs back to the boiler-room into the hot well. The air piping originates in the boiler-house, which adjoins the shop at the lower left-hand corner of the plan view; and 1¼-inch branches run along inside of each of the working pits. There are three ¾-inch Jenkins' valves for each engine. Three-inch steam and water pipes are carried in the center pit the full length of the building. Connections are furnished for every four engines, gate valves being used for this purpose. The steam pipes are connected with a high pressure boiler for the purpose of testing locomotive boilers under steam pressure without firing them up in the shop. The pits are carefully drained.

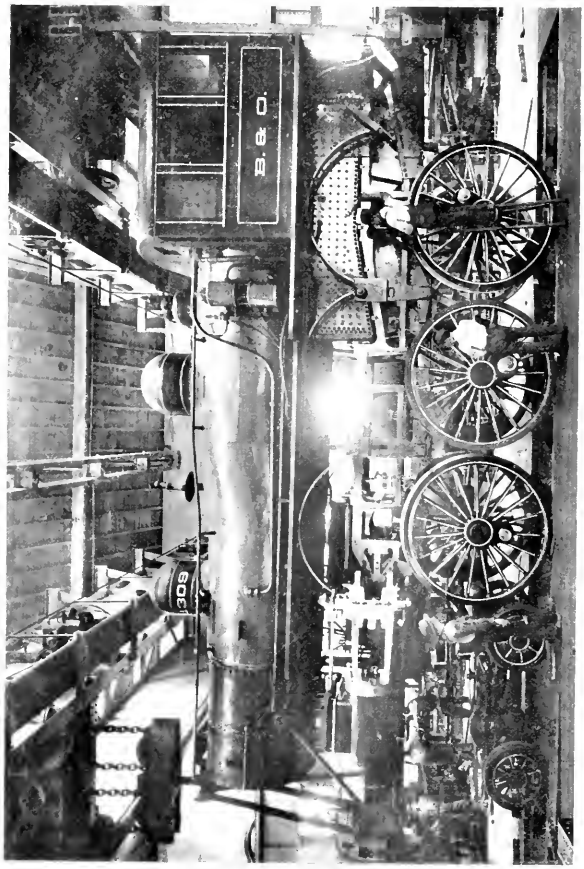
At the right-hand end of the plan view the basement is shown. In this the water closets, wash troughs and clothes lockers are placed, the room being reached from the main floor by a stairway, and the passage between the wash-room and the closets is closed by a sliding glass door. On the opposite side of the same end of the building is another basement room used for the storage of tools and supplies. These basements have nearly nine feet head room and they are 130 feet long by about 12 feet wide. Originally the building had a basement extending about one-third of its length. That portion lying between the side track and the south wall has been fitted up as a storage room, and the portion between the side track and the north wall has been fitted up as a washroom and water closet. The washroom is provided with cast-iron tubs and hot and cold water, and is so arranged that an independent supply of water is directed into the tubs for each employee, and around the walls of this room convenient hooks will be placed for the reception of coats, hats and lunch baskets of the employees, and the room will be kept locked until just prior to quitting time. The ground line being about nine feet below the floor line at this point on the north side makes it possible to properly light the washroom and water closet. The ground is about level with the shop floor on the south, west and east sides but on the north side at the east end it is nine feet below. The



Erecting Shop, Mt. Clare; Baltimore & Ohio Railroad.—Plan View.



Transverse Section of Erecting Shop.



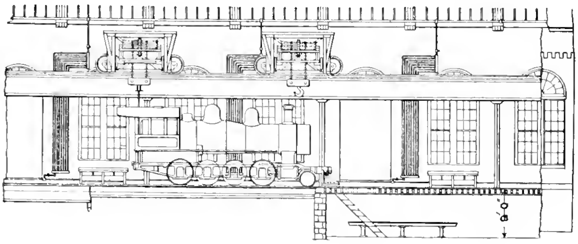
From a Photograph of a Locomotive Raised by the Electric Cranes.

building was formerly divided into three nearly equal parts by two partition walls of brick which were removed and the floor was lowered about one foot to facilitate the handling of material between the machine and erecting shops. The roof was provided with ventilators and with skylights throughout its entire length.

At the west end of this building will be located a paint shop for finishing up the locomotives after they have been repaired, and to the south are tracks for the storage of locomotives awaiting repairs. To the north, next adjoining the erecting shop, the tender shop is located, and further on to the north is the boiler shop' with tracks connecting with the central track leading from the west end of the erecting shop. The south end of the machine shop, east of the erecting shop, was formerly used as an erecting shop. This floor space has been utilized for the rearrangement of the machine tools, many of which were removed from the second story of this building, and thereby placing all of the tools for locomotive work on one floor, and permitting the use of the second floor for other purposes.

The tools are arranged in rows forming avenues running north and south. Crossing these avenues and near the center of the machine shop is an extension of the central track from the new erecting shop, upon which the material between the two shops is transported. The east end of this track extends into the yard, connecting with the tracks for receiving material from the blacksmith shop and foundry.

Formerly the repairs to locomotives at Mt. Clare were made in two buildings, a portion of the work being done in the machine shop above mentioned, and the remainder in an old locomotive



Sectional View Showing Cranes.

roundhouse. Beginning with the use of the new erecting shop, the work was discontinued in the other buildings, thereby permitting the removal of the old locomotive roundhouse and the laying of straight tracks leading to the south wing of the paint shop. The roundhouse was so located as to interfere with the use of this portion of the shop for passenger car repairs, which is now made possible; with the introduction of straight tracks, additional standing room for cars outside of the shop is also secured.

We are indebted to Mr. Harvey Middleton and to Mr. J. H. Maddy for the drawings and photograph.

Railway Accidents in Great Britain in 1896.

The total number of personal accidents on the railways of the United Kingdom reported to the Board of Trade during 1896 amounted to 1,093 persons killed, and 16,879 injured. These figures, says *Engineering*, include all accidents of whatsover description occurring on railroad companies' properties. The number of passengers killed in train accidents was only five, which is far below the average of preceding years, the average for the previous five years being 15. The number of passengers injured was 388, against 399 in 1895. Of the 54 train accidents investigated by the Board of Trade officials, six took place on the Glasgow and South-Western, which had a train mileage of 6,351,525, giving approximately one accident per million train miles; five on the North British, for a train mileage of 16,729,013, or one accident in 3¼ million miles run; four on the Caledonian, with a train mileage of 15,658,634, or one accident in four million miles; four on the Great Eastern, with a train mileage of 19,292,134, or one in 4¾ million miles; four on the Great Northern for 20,921,018 miles, or one in 5¼ million miles; four on the Lancashire & Yorkshire, with a mileage of 17,079,467, or one in 4¼ million miles; four on the South-Eastern, with a mileage of 8,238,937, or one in two million miles; three on the London and North-Western, with the enormous train mileage of 43,303,238, or one in 14½ million miles; three on the Manchester, Sheffield & Lincolnshire, with a train mileage of 9,667,435, or one in 3¼ million miles; three on the North-Eastern, with a train mileage of 28,914,339, or one in 9½ million miles; two on the Great Northern of Ireland, with a total mileage of 3,372,429, or one in 1½ milion miles; and two on the London, Brighton & South Coast, with a total number of 9,912,867 miles run by trains, or practically one in five million train miles. Of the remaining accidents, not more than one occurred on any one railway.

It is satisfactory to note that during the year, out of a total of 89 accidents reported to the Board of Trade, not one was attributable to inadequate or unsuitable brake power. The gradual growth of the employment of continuous brakes has effected a wonderful improvement in this respect. Some 10 years ago the inadequate brake power provided on our rails was one of the most fruitful sources of accident.

In consequence of the observations of the inspecting officer who held the inquiry into the accident that occurred in the latter part of 1895 to a passenger train, through the breaking of a rail at St. Neots on the Great Northern Railway, the Board of Trade appointed a Departmental Committee "to inquire into the extent or loss of strength in steel rails during prolonged use on railways under varying conditions, and to ascertain what steps can be taken to prevent the risk of accidents through such loss of strength." The committee has held a number of meetings, and is carrying out a series of tests of selected rails, which are also subjected to a chemical and micrographical analysis, but has not yet made its report to the Board of Trade. In the meantime the particulars furnished by the companies of rails found broken are carefully watched with a view to suggesting, if necessary, the substitution of more suitable types of rails at the places where the failures have occurred.

A New Correspondence School.

The Correspondence School for Locomotive Engineers and Firemen which was started June 9, 1897, at 331 Dearborn street, Chicago, is enjoying an encouraging growth. The membership is drawn from 37 railroads and now numbers over 2,800. Each member receives a set of 10 questions by mail each week and these are sent in for correction while another set of questions is on its way to the student. About 40 questions in the form of an examination must be answered at the end of each quarter and a final examination will be held at the end of the year and a certificate will be issued stating the grade earned by the student. The courses for engineers and firemen are separate and students are expected to ask questions whenever they desire. Mr. W. N. Mitchell is the General Superintendent of the school, and he has been very active in bringing it before railroad men and railroad officers. The undertaking is a worthy oue, and it deserves success and encouragement.

Steam Motor Car, New England Railroad.

In the editorial columns of this issue will be found a statement of the new conditions brought about in suburban steam transportation business by trolley railroad competition, and in this connection we are glad to present a description of the design brought out by the Schenectady Locomotive Works to meet the new requirements. About seven months ago Mr. C. Peter Clark, General Manager of the New England Railroad, consulted the officers of the Schenectady Locomotive Works with reference to the design of a light combination equipment, and the work was undertaken. After much study the result was the set of plans from which this car and another for the Erie Railroad were built. The design of such equipment may appear to be a very simple matter. It is, however, exceedingly difficult to secure the necessary power, endurance and ability to accelerate a train with the necessary compactness and the freedom from oscillation or vibration communicated to the train. It would be easy to produce a design using flexible steam pipe connections, but to arrange the whole affair as well as has been done in this case requires ingenuity, skill

and experience in working out similar problems. Many will look upon this as a "rehash" of old ideas, the old steam dummy thrust forward again; and so it is, but it is brought out on new lines for new purposes. The arrangement of the machinery will bear the closest scrutiny and criticism, and we believe that it will be generally considered as a good design which is based on the best locomotive practice. Other locomotive builders are engaged upon a similar problem, and we hope to present the result of their efforts a little later.

The car is an old dining car formerly having two six-wheel trucks. The forward end is carried on the locomotive truck and the other truck is retained unchanged. The frame of the car was reinforced by steel bracing and a partition placed across the car immediately behind the engine space. Water tanks holding 1,400 gallons of water were hung between the trucks and the windows and front platform were rearranged. The boiler is vertical with vertical tubes and an enlarged steam and water space at the top. The engravings show it without the jacket, and it is an admirable piece of work. One of the specially good features of the vertical type of boiler for this service is that the water level may fluctuate between rather wide limits without exposing a crownsheet or causing any serious danger, and this renders the equipment more suitable for one man to handle. The air pump is secured directly to the boiler as are all of the steam fittings. In the end view the steam and exhaust pipes are best shown. The one at the right is the steam pipe and is surmounted by the throttle, to which the throttle lever is connected by a rocking rod across under the roof of the car, provision for the rotation of the truck being provided by a universal and slip joint. The exhaust pipe runs into the boiler near its top and opens under the smokestack. There are no moving joints in the steam and exhaust pipes, which is an important recommendation of the design. The arrangement of the steam and exhaust pipes to and from the cylinders is also shown in the end view of the machinery, from which it will be seen that they pass up inside of the bearing of the car, whereby flexible connections are avoided.

The boiler is mounted on a pair of frames with pedestal jaws, and the whole truck is similar to an engine truck with wrought-iron locomotive frames, equalizers and leaf springs. The frames are flattened out into slabs at the front ends, and the cylinders and the connecting casting are bolted to them. The other ends of the frames carry the air reservoir. The cylinders are 12 by 16 inches, and the driving wheels are 42 inches in diameter, the boiler pressure being 200 pounds per square inch, although the boiler may carry higher pressures if found desirable. The valve gear is the Walschaert type, which is admirably adapted to the rest of the design, and is easily accessible. The valves are the American Balance Valve Company's type. The crossheads are of the Laird type, which was selected on account of the low cylinders. The bell, whistle and cylinder cocks are operated by air pressure, the latter being opened and closed by the small cylinder secured to the front side of what would ordinarily be termed the saddle casting. The side rods are strap ended.

A casting in the form of a ring rests upon the frames and encircles the boiler. This is grooved to receive 125 1½-inch balls and a similar casting, secured to the reinforced car floor, rests upon the balls, forming a bearing which is one of the chief features of the design. The boiler is fed by two Sellers' injectors of different sizes, and the suction pipes connect to the injectors by short lengths of hose. Hose connections are used for the air pipes and for the reverse lever connection. A location was determined for the reach rod, which permitted the swinging of the truck to change the angle of the connection without affecting its length. The air brakes on the driving wheels were applied as to any truck. The care and attention bestowed upon this engine are worthy of remark, and it is clear that the builders considered it a subject demanding their best knowledge and ability.

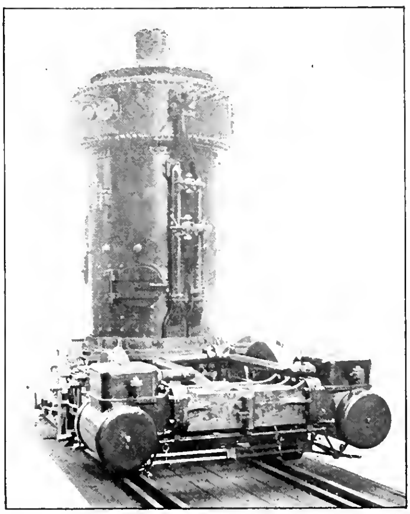
On a trial trip, on a track with a grade of from 50 to 58 feet per mile and three miles long, the car maintained a speed of 30 miles per hour when hauling a regular passenger coach as a trailer. Without the trailer and on a level track, with a start of

Steam Motor Car.—New England Railroad.

one-quarter mile, the car covered five successive miles in five minutes and 55 seconds, as follows:

First mile, 1 minute 20 seconds.
Second " 1 " 10 "
Third " 1 " 5 "
Fourth " 1 " 7 "
Fifth " 1 " 13 "

The car seats 60 persons and will be operated by two men. The fuel is coke or anthracite coal, and there is sufficient capacity for fuel and water to enable the car to run 60 miles without replenishing. The car is equipped with the Golmar bellringer and the Leach sanding apparatus. Its first work will be upon the Milford branch.



Boiler and Machinery of Steam Motor Car.

The following table gives the general dimensions of the engine and car, together with a number of items of interest concerning the design:

GENERAL.

Gauge	4 feet 8½ inches
Fuel	Coke
Weight in working order	115,000 pounds
Weight on drivers	70,000 pounds
Wheel-base, driving	8 feet
Wheel-base, total	56 feet 10 inches

CYLINDERS.

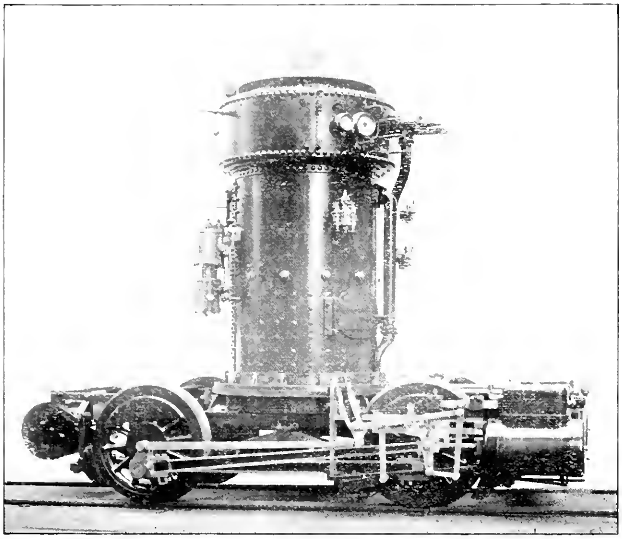
Diameter of cylinders	12 inches
Stroke of piston	16 inches
Horizontal thickness of piston	4½ inches
Diameter of piston rod	2 inches
Piston packing	Cast-iron rings
Steam ports	10 by 1 inch
Exhaust ports	10 by 2 inches
Bridges	1 inch

VALVES.

Valve gear	Walschaert
Valves	American balanced
Greatest valve travel	4½ inches
Outside lap	¾ inch
Inside lap	Line and line
Lead of valves, full gear	Constant ⅛ inch

WHEELS AND JOURNALS.

Diameter driving wheels, outside tire	42 inches
Centers	Cast iron
Driving boxes	Steeled cast iron



Boiler and Machinery of Steam Motor Car.

BOILER.

Style	Circular, upright, with steam drum
Outside diameter	Top, 63 inches; bottom, 52 inches
Working pressure	200 pounds
Thickness of plates	½, $\frac{9}{16}$ and $\frac{11}{16}$ inches
Horizontal seams	Double, with welt inside, quadruple riveted
Circumferential seams	Single riveted
Firebox, diameter	15⅜ inches
" depth	47½ inches
" plates	Sides $\frac{5}{16}$, tube sheet ½ inch
Water space	3 to 3½ all around
Staybolts	Taylor iron, 1 inch diameter
Tubes, number of	318
" diameter of	1¼ inches
" length of, over sheets, about	4 feet 8½ inches
Heating surface, tubes	5,896 square feet
" " firebox	53.3 square feet
" " total	6 429 square feet
Grate area	11 23 square feet
" style of	Reagan, chopper
Ash pan	Plain
Exhaust pipes	Single
Smoke stack above rail	11 feet
Injectors	Two Sellers Class "N."

MISCELLANEOUS.

Water capacity of tanks	700 gallons each
Headlight	16-inch Star
Boiler covering	Magnesia sectional
Safety valves	2, 2½-inch Crosby, side outlet
Air-brakes	Westinghouse
Bell ringer	Gollmar

The Relative Cost of Narrow and Standard Gauge Railroads.

A correspondent in a Western state recently wrote to Mr. M. N. Forney, saying that he "would like to know how much less the first cost of building and equipping a narrow-gauge road would be, say of $10,000 per mile for a standard gauge." The following reply is a concise refutation of the arguments in favor of narrow-gauge railroads, which were advanced 25 or 30 years ago, and which are often repeated and still believed by some people, but whose force has been almost entirely dissipated by the logic of events and experience. It may be said, too, that when the great furore in favor of narrow-gauge roads swept over the civilized world in the seventies, the *Railroad Gazette*, of which Mr Forney was then one of the editors, was the only engineering paper which opposed and refuted the fallacies advanced in support of that system. Experience has shown that the paper referred to was right in the position it then took and all the others were wrong.

Mr. Forney's letter in reply to the Western inquirer is as follows:

Yours of the 4th has been received. I do not think there would be any difference in the cost of a light narrow and an equally light wide gauge road, if the rolling stock is of the same character in each case.

Of course, if you build a standard gauge road and equip it with heavy cars and locomotives it will cost more than a narrow gauge will with light cars, locomotives and rails. I am assuming that the road is for ordinary traffic and in the open country and not in a coal mine or other contracted place.

I think my position will be made clear to you, if you or your friends will determine what kind of cars—passenger and freight—will be required on, say, a 3-foot gauge road to accommodate the traffic of the country in which it is built. That is, determine in advance how much load each of your cars should carry, and the length, width and height of their bodies. Next ascertain the maximum grades which the road must have and the minimum radii of curves for such a 3-foot line, and also the maximum weight of trains to be hauled over these grades and curves. Now, having your specifications for cars, get estimates of their cost from any car manufacturers you choose, the cars to be built to the specifications. At the same time get from the same parties the cost of cars with the same size and capacity of bodies, the same-sized wheels, springs and truck side frames, the only difference being in the increased length and size of axles, and transverse members of the trucks. I will venture a new hat as a wager that you can get such cars for a standard gauge road at as low a cost as similar cars for a 3-foot gauge, and the difference in weight between them will be so small an item as not to be worth consideration.

On the other hand, the standard gauge has an advantage so far as the weight of cars is concerned. As a rough rule, it may be assumed that the width of a car body should not be greater than twice the gauge, so that for a 3 foot road the bodies should not exceed 6 feet in width. For a 4-foot 8½-inch gauge they may be 9 feet 5 inches wide. We will suppose that narrow-gauge cars 6 feet wide must be 30 feet long to accommodate the traffic of a line. They would have 180 square feet of floor area. If cars for a light standard-gauge road were, say 9 feet wide and only 20 feet long, they would have the same floor area. At the same time the longitudinal floor timbers, which from the frame of the car body, being only 20 feet long instead of 30, would not only be lighter, on account of their shortness, but, for the same reason, their transverse dimensions could be less for a given amount of strength. Besides this, the length of the enclosing sides and ends of the long, narrow cars would be 30 feet + 30 feet + 6 feet + 6 feet = 72 feet, whereas that of the wider cars would be 20 feet + 20 feet + 9 feet + 9 feet = 58 feet only. That is, the enclosing walls of the wide car would be 14 ft. shorter and therefore of less weight. I therefore feel sure that a skillful designer of cars could make them for a standard gauge, and suitable for the traffic of a narrow gauge road, which would be lighter and cheaper than any of equal strength and affording equal facilities for carrying freight and passengers for a 3-ft. gauge road. Of course, I am speaking of cars for ordinary traffic and not for a road in a coal mine or to run about a manufacturing establishment. Keep carefully in mind that if a car body of given capacity and dimensions will accommodate a given traffic on a narrow-gauge road, it will be equally suitable on a standard gauge line for the same traffic. So much for cars.

Now having decided what weight of trains must be hauled, the maximum grades and minimum radii of curves of road, get bids for narrow and for standard gauge locomotives of the requisite capacity to haul such trains over such grades and curves,

and I will risk another hat, on a wager, that you can get the one kind for as little money as the other, and probably, if the trains are even moderately heavy and the grades steep, the wide-gauge engines will cost somewhat less than those of equal capacity for a narrow road.

You will probably be told that curves of shorter radii may be used with a narrow gauge than is possible if the rails are wider apart. Volumes have been written to prove scientifically that shorter curves can be used on narrow than with wide gauge roads. All the arguments so laboriously evolved were exploded when the New York Elevated Railroads were built with curves of only 90 feet radii, and these roads have been operated for some 20 or more years, and during that time more trains have been run over them daily than over any other roads in the world, and the whole of them pass over these curves. No 3-feet gauge road has ever used curves of so short a radius on its main line for any considerable time.

But the narrow-gauge advocates will triumphantly say the rails may be lighter if they are placed nearer together than they can be if they are farther apart. Why? If the wheels of a car of a given weight are placed 4 ft. 8½ in. apart under a car of a given weight, will the law of gravitation work any differently than it would if they were only 3 ft. apart? In the beginning of the narrow gauge discussion Mr. Fairlie, who was the great champion of such roads, formulated the proposition that "the dead weight of cars was in direct proportion to the distance between their wheels." The reply made to this was that if the principle stated was true, then a wheelbarrow and a bicycle would be imponderable, and, therefore, if the tires of the latter were filled with hydrogen gas it would float away into space. The fact is that with a given weight of cars the rails may be of the same weight, no matter what the gauge is.

In the old discussion of this subject various engineers who took part in it asserted that cuts and embankments and tunnels could be narrower if the rails were near together than they could be if their gauge was wider.

Obviously this is not true of tunnels or cuts, because the width of these is governed by the width of the car bodies, and if narrow car bodies have any advantages, or are adapted to the traffic, as said before, they can be used on a standard gauge.

The width of a fill or embankment is governed by the length of the ties or sleepers. In the early days of narrow-gauge construction they laid three feet gauge tracks on ties six feet long. As the new roads were generally unballasted, these short ties soon sank into the mud, consequently longer ones had to be substituted. As a matter of fact, the length of a tie and its bearing surface must be governed not by the gauge but by the weight of cars and engines which they must carry. If the rolling stock is made as light for a wide as for a narrow gauge, there is no reason why the ties need be any longer in the one case than in the other to carry it. The width of the fills with rolling stock of a given or equal weight, may, therefore, be the same for either gauge.

Of course the incidental expenses, engineering, officers' salaries, office expenses, accounting, etc., are the same for either gauge. A standard gauge line has though the overwhelming advantage that the cars of ordinary roads, if not loaded too heavily, can always be run over it, whereas transshipment or at least a transfer of trucks is required if there is a break of gauge. Then, too, a a light standard gauge may gradually be improved by laying heavier rails when the first ones are worn out and improving the rolling stock, thus converting it to a standard road, whereas this is not possible if the gauge differs from that of all other roads.

I hope I have made the various points clear. The important fact to keep in mind is that you can build a light standard gauge road just as readily as a light one of narrow gauge. Of course a heavy standard road will cost more than a light narrow one—any idiot may know that. There are other idiots though who assume that light rolling stock will afforded every needed accommodation for traffic on a narrow-gauge line, but for some inscrutable reason they seem to think it would not do so if the same car bodies were carried on wide-gauge tracks. A surgical operation and not argument is needed with such people.

Yours truly,
NEW YORK, August 11, 1897. M. N. FORNEY.

The Kaiser Wilhelm der Grosse.

The new North German Lloyd twin screw ship *Kaiser Wilhelm der Grosse*, for which so much has been expected, reached New York on the evening of Sunday, Sept. 26, having beaten the record. The greatest run for one day was 564 knots, which is two more than the best run of the *Lucania*, which had previously held the record of a day's steaming. The average speed per hour was 21.39 knots, and the daily runs were 531, 495, 512, 554, 564 and 186 knots.

The coal consumption was about 500 tons per day. The speed of the screws was 77 revolutions per minute. The coal bunker capacity is 4,950 tons and enough can be carried for a round trip. The engineer's staff consists of 17 engineers, 18 oilers, 90 firemen and 75 coal passers, and it is stated that 12 extra firemen were carried on the first trip; this, however, does not detract from its success as a maiden trip. The length of the ship is 648 feet, the beam 66 feet, the depth 43 feet, the tonnage 13,800 tons and the displacement 20,000 tons. With the exception of the Hamburg-American freighter *Pennsylvania* she surpasses every ship afloat. The *Pennsylvania* has about 3,000 tons more displacement when fully loaded. The *Kaiser Wilhelm* has bilge keels and a very high freeboard forward, about 15 feet more than the *Lucania* or *Campania*. The ship is divided into 16 transverse compartments extending to the upper deck, and the longitudinal compartment between the engine-rooms brings the number of separate compartments to 18. The boilers are arranged in four groups of three boilers each, in a separate compartment. The ship has a double bottom with 22 subdivisions and these safety provisions are supplemented by 24 lifeboats.

The engines, which are on the Schlich system, have four cylinders and four cranks; they were built by the Vulcan Shipbuilding Company, of Stettin, also contractors for the hull, and have cylinders as follows: high pressure, 52 inches; intermediate, 89¾ inches, and two low pressure cylinders, 96½ inches. The stroke is 68.9 inches. The crank and propeller shafts are of Krupp nickel steel, and are 24 inches in diameter. Each crank weighs 40 long tons, and the length of the shaft over all is 198 feet, from which the enormous proportions of the machinery may be imagined. The twin propellers have three blades each, and are 22 feet 3¾ inches diameter, with 32 feet 10 inches pitch. The material is bronze and the weight is 26 tons. The combined cooling surface of the two condensers is 35,522 square feet, the number of tubes being 11,060. In the engine and boiler spaces there are 47 engines and pumps aside from the main engines, and the total number of engines in the ship is 68, with 124 cylinders. Four centrifugal pumps are provided, together with six duplex pumps, the combined capacity being 3,600 long tons of water per hour. The boilers number 12, with eight furnaces each, or a total of 96 furnaces. The funnels are 106 feet high from the level of the keel, the diameter being 12 feet 2 inches.

The crew numbers 450, and the ship has 200 staterooms for 400 first saloon passengers, 100 second-class cabins for 350 passengers, making 750 passengers in all, and it is stated that on her first trip 600 saloon passengers were carried. There are four decks. The promenade deck extends from the stem to within 145 feet of the bow and is 500 feet long. The second-class accommodations are at the after end of the ship.

For purposes of comparison we give some figures of the sizes of several large liners as follows:

	Length. (b. p.)	Breadth.		Tonnage.	Indicated horse-power.
	ft.	ft.	in.		
Kaiser Wilhelm der Grosse..	625	66	0	13,800	28,000
Campania and *Lucania*......	600	65	0	12,500	28,000
St. Paul and *St. Louis*........	535	63	0	11,600	20,000
Paris and *New York*.........	527.6	63	0	10,499	20 000
Fuerst Bismarck...	502.6	57	3	9,000	17,000
Majestic and *Teutonic*........	565	57	6	9,686	19,500

The Sunset Limited.

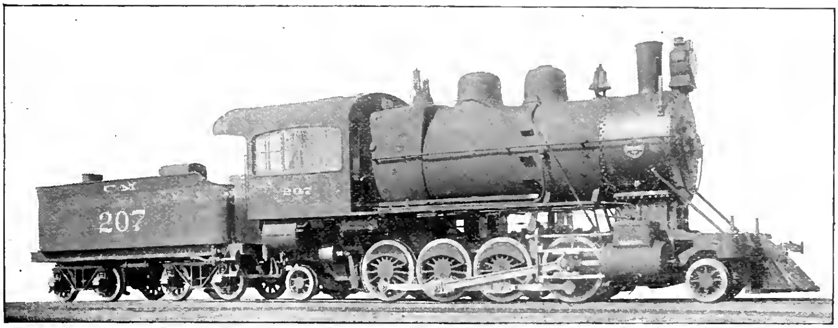
The new 'Sunset Limited" train was on exhibition in Chicago recently and has attracted a great deal of favorable attention. The train runs semi-weekly to California, via the Chicago & Alton, from Chicago to St. Louis; the St. Louis, Iron Mountain & Southern from St. Louis to Texarkana and the Southern Pacific from El Paso to the California destination. The trains leave Chicago at 1:30 p. m. Tuesdays and Saturdays and makes the run of 2,936 miles in three days.

The train throughout is composed of some of the finest equipment that the Pullman Company has been able to turn out. It consists of a combination baggage, buffet and library car, with barber shop and bathroom attached, a private compartment and chair, two 12-section sleepers with double drawing-rooms at each end and a dining-room car. The numerous guests recently invited to inspect the train in Chicago expressed themselves as delighted with the elegance and luxury of this equipment and congratulated the companies concerned on the bright prospects under which the new service is starting. We acknowledge the courtesy of Mr. W. G. Neimyer, General Western Freight and Passenger Agent, 238 Clark street, Chicago, for an attractive pamphlet describing the train and giving complete information in regard to it.

Heavy Freight Locomotive—Mexican Central Railway.

THE BROOKS LOCOMOTIVE WORKS, BUILDERS.

Our engravings show the principal features of a new heavy freight locomotive recently built for the Mexican Central Railway for use on the Tampico Branch upon the Tamascopo Mountain. The design is of special interest because of the fact that several other heavy locomotives have been recently built for somewhat similar service, with which it may be compared. It was specially designed for a grade of 27 miles, of which a continuous grade of three per cent. extends over a length of 19 miles. Upon this grade there are numerous 23½-degree curves, and many of them are more than 180 degrees in length. The engine was designed and built by the Brooks Locomotive Works, and is the largest and heaviest ever built there, the total weight being about 193,450 pounds, of which 145,200 pounds are on the driving wheels. The engine has eight coupled wheels and two pony trucks. The boiler is the Player patent, Belpaire type, with three rows of sling stays at the front end of the crown sheet. The boiler is very large, the diameter of the first course being 78 inches. The fuel is to be bituminous coal and mesquite wood. Of the latter there is a large available supply where this engine is to be used. For convenience in comparing this engine with several other large ones, the following table has been prepared:



Heavy Freight Locomotive, Mexican Central Railway.

TABLE OF COMPARISON OF SIX HEAVY LOCOMOTIVES.

Builder and type...... Railroad..............	Brooks, simple. Mexican Central.	Schenectady, compound. N. P. Ry.	Pittsburg, simple. B. & O. R. R.	Pittsburg, simple. D., M. & N. Ry.	Baldwin, simple. Buffalo & Susquehanna.	Schenectady, simple. D. & I. R. R. R.
Total weight..........	193,450 lbs.	186,000 lbs.	168,0 0 lbs.	160,000 lbs.	163,550 lbs.	169,000 lbs.
Weight on drivers...	145,200 lbs.	150,000 lbs,	152,800 lbs.	141,000 lbs.	117,250 lbs,	139,000 lbs.
Size of drivers........	49 in.	55 in.	54 in.	50 in.	51 in.	54 in.
" cylinder	21 × 26	23 × 34 × 30	22 × 28	22 × 28	22 × 26	22 × 26
H. S. Firebox..........	218 sq. ft.	2 6.51 sq. ft.	183.64 sq. ft.	169.5 sq. ft.	189.5 sq. ft.	189.7 sq. ft.
" total.	2,803 sq. ft.	2,913.41 sq. ft.	2,315 64 sq. ft.	2,318.7 sq. ft.	2,244 sq. ft.	2,402.3 sq. ft.
Firebox......	37¾ in. × 120 in.	42 in. × 120 3/16 in.	41 in. × 115 in.	42¼ × 121 in.	42 × 121⅛. in.	41⅜ in. × 120⅛ in.
Grate area............	31.45 sq. ft.	35 sq. ft.	32 7 sq. ft.	35.5 sq. ft.	35.3 sq. ft.	31.5 sq. ft.
Steam pressure.......	180	200	180	160	180	180
Size of boiler....	78 in.	72 in.	64 in.	72 in.	72 in.	72 in.
Kind "	Belpaire.	Extended wagon top.	Extended wagon top.	Straight.	Straight.	Straight.
Staying...........	....	Radial.	Radial.	Radial.	Rad al.	Radial.
Tubes......	412, 2 in. diam. × 12 ft. 1¼ in.	332, 2¼ in. diam. × 14 ft.	246, 2¼ × 11 ft. 8½ in.	272, 2¼ × 13 ft. 6 in.	260, 2¼ × 13 ft. 6 in.	230, 2¼ × 13 ft. 6 in.

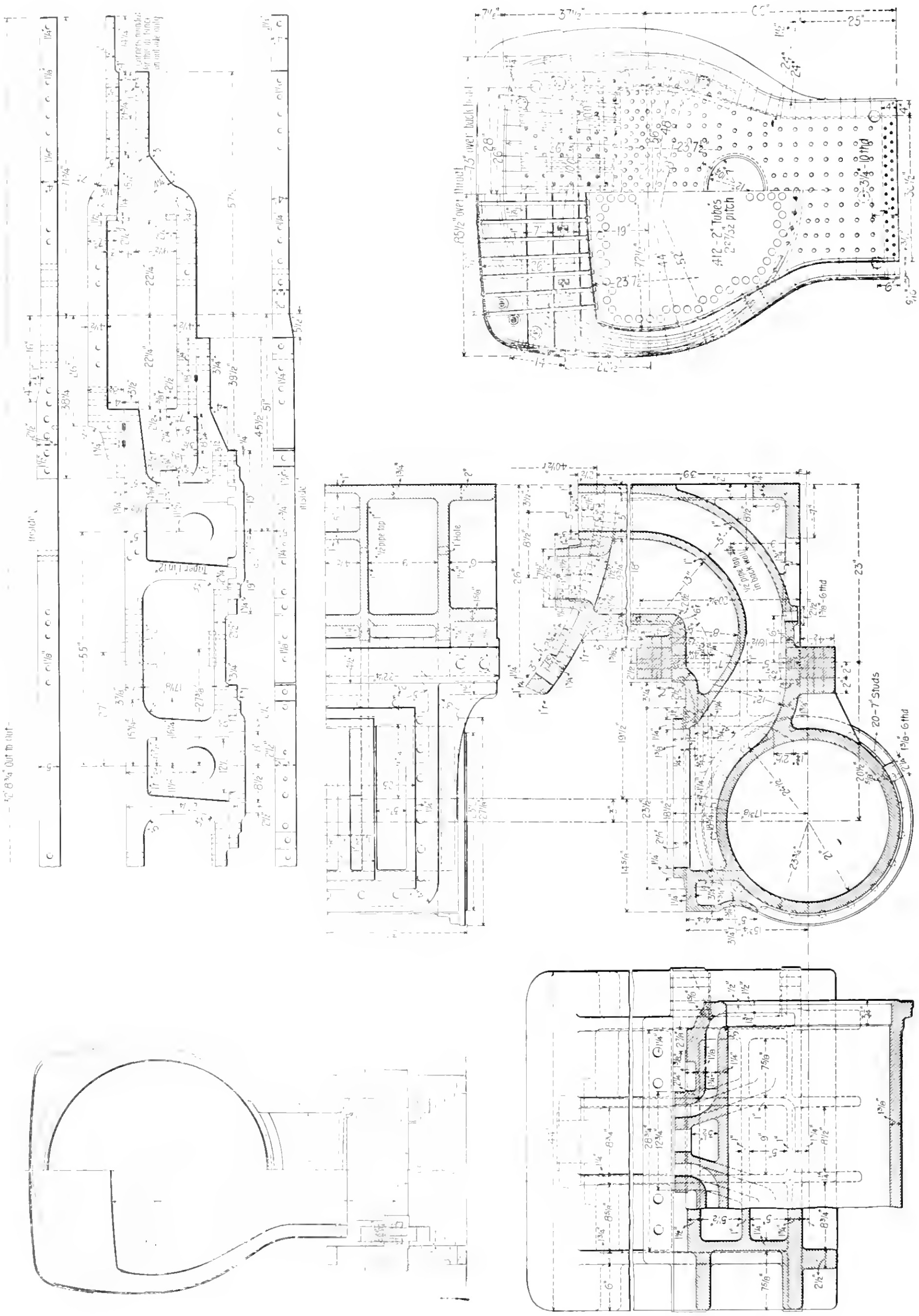
The boiler construction is clearly shown in the engravings. The number of tubes, 412, is very large and they could not be accommodated in a small boiler. They are not as long as are those of the other large engines covered by the table, but the heating surface, 2,803 square feet, is very large and not exceeded by any engines except the compounds for the Northern Pacific, which we illustrated last March (The AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL, March, 1897, page 97). The firebox is above the frames, which are straight on top from the forward pedestals to the back ends. The grate area is 31.45 square feet, which is somewhat smaller than that of the other designs. The firebox is 10 feet long by 37¾ inches wide, the depth being 75 inches at the back and 82 inches at the front end. This type of boiler is too well known to require comment further than to call attention to its large size and to the three rows of sling stays at the front end of the crown sheet, and to the four long 3½ by 1½ inch braces from the front course to the back head. The engravings show the method of attaching these braces, and also the other bracing of the back head by means of the 1½-inch round rods which pass through the upper part of the water legs along the sides of the wide portion of the firebox, and also those used to stay the upper corners of the back heads. Angles, 6 by 6 inches in size, are used to stiffen the back heads for the rods that pass along on each side of the firebox. The working pressure is 180 pounds. The boiler covering is Johns fire felt.

The cylinders are 21 by 26 inches and the driving wheels are 49 inches in diameter. The cylinders are secured to the smoke arch by means of a double row of bolts all around, and a glance at the frame drawing will show the front connection to be a strong one. The frames are 5 inches thick. The pedestal braces receive projections from each jaw, as shown in the drawing of the frames, and while this is not a complete view the chief features of interest are shown. The crossheads are of the alligator type.

The weight of the boiler is carried to the frames by four large expansion pads which are riveted to ⅝-inch liner plates, 76 inches long by 20 inches wide, fastened to the firebox on each side for the purpose of stiffening the sheets and distributing the stresses over a large area.

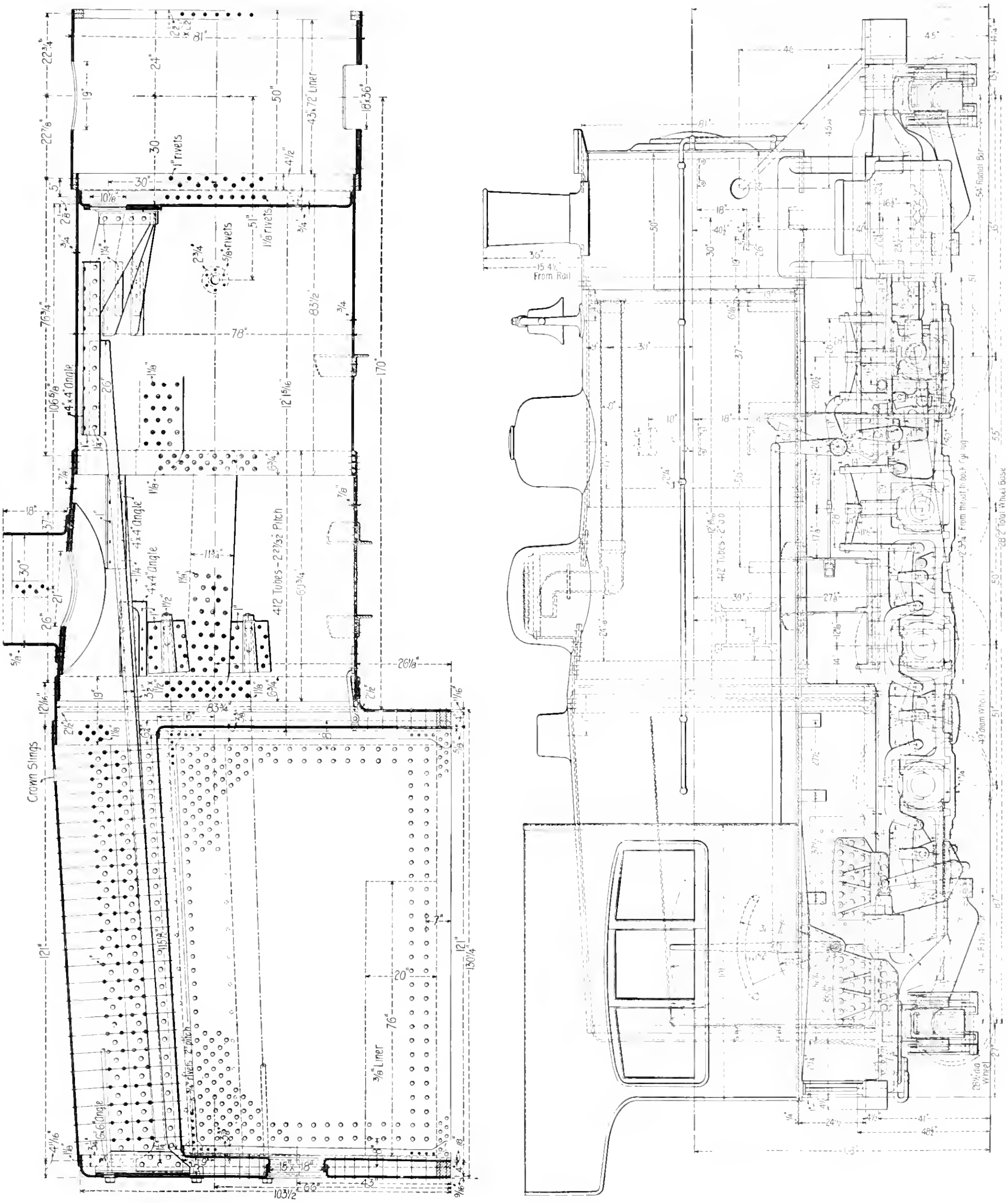
The trucks and the equalizing arrangements are clearly shown in the drawings. The truck springs are over the boxes and the method of loading the truck is seen in the sectional views. The forward pair of drivers are equalized with the truck and the others are equalized with each other, as shown.

The arrangement of the attachments on top of the boiler is good. The bell is immediately back of the stack and the sandbox is back of the bell. The throttle dome is placed on



HEAVY FREIGHT LOCOMOTIVE.—MEXICAN CENTRAL RAILWAY.

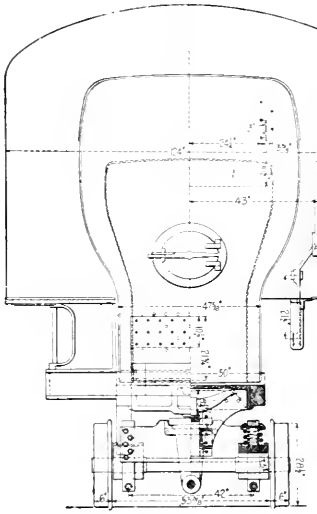
MR. F. W. JOHNSTONE, *Superintendent of Motive Power and Machinery.* THE BROOKS LOCOMOTIVE WORKS, *Builders.*



HEAVY FREIGHT LOCOMOTIVE.—MEXICAN CENTRAL RAILWAY.

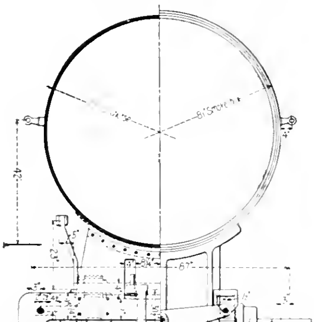
MR. F. W. JOHNSTONE, *Superintendent of Motive Power and Machinery.* THE BROOKS LOCOMOTIVE WORKS, *Builders.*

the taper connection sheet and the pop valves and whistle are on a small dome by themselves, located over the front end of the firebox. The cab is of steel. It is wide enough to give 25 inches clear space on each side of the boiler. The throttle lever is over the reverse lever and is connected to the throttle stem in the back head by a rod and rocking lever. The injectors, which are of



Heavy Freight Locomotive.

the Friedman type, are under the running boards and are operated by handles from the deck. The air pump is located on the connection sheet on the fireman's side, and there is a main reservoir on each side of the engine under the running boards. The engine has Le Chatelier water brake, Westinghouse American brakes, the Westinghouse train signal and Player brake-



Heavy Freight Locomotive.

beams. The driving wheels are cast steel, made by Pratt & Letchworth, and the tires are of Krupp crucible steel. The truck wheels are 28½ inches in diameter, with cast-iron centers and Krupp tires. Cast steel is used for the cylinder heads, steam chests and covers, pistons and driving boxes. Malleable iron is used for the steam pipes, center castings, side bearings and truck boxes for the tender.

The tender trucks are of the patented design of Mr. A. A. Robinson, President of the road. They have channel-iron transoms and no spring plank, the springs resting on the tops of the boxes. It may be necessary to sometimes connect the tender with an auxiliary tank, and for this purpose a pipe is arranged so that the injectors may be fed from the auxiliary. The tender frame is of 9-inch channels and is built in accordance with the practice of the road.

The following list gives the chief dimensions of the engine.

Fuel	Bituminous coal and wood
Weight in working order	193,450 pounds
Weight on drivers	145,000 pounds
Rigid wheel base	13 feet
Total wheel base, engine	28 feet
Total wheel base, engine and tender	53 feet
Cylinders, size	21 by 26 inches
Slide valves, kind and make	Richardson balanced
Steam ports	18½ by 1⅝ inches
Exhaust ports	18½ by 3 inches
Bridges	1½ inches
Driving wheels, diameter ou side of tire	49 inches
Driving wheel centers	Cast steel
Tires, kind and make	Krupp crucible steel
Engine truck wheels	28½ inches diameter
Boiler	Improved Belpaire wagon top
Outside diameter at smallest ring	78 inches
Working pressure	180 pounds
Boiler covering	Johns fire felt
Fire box..Length, 120 inches; width, 37¾ inches; depth, 75 inches back and 82 inches front.	
Tubes	412; diameter, 2 inches
Heating surface, tubes	2,585 square feet
Heating surface, firebox	218 square feet
Heating surface, total	2,803 square feet
Grate surface	31.45 square feet
Tender wheels	Diameter, 23 inches
Tender frame	9 inches; channel steel
Tender capacity	4,500 gallons; coal, 5 tons
Bearings, kind of metal	R. R. Co.'s mixture
Brakes, Westinghouse	American
Brakebeams, tender	Player
Train signal	Westinghouse
Safety valves	3 by 3 inches; Crosby
Lubricators	Nathan
Injectors	Friedman's W. F.
Gages	Crosby
Whistle	Crosby chime
Springs	Scott Spring Company
Headlight	Glazier circular case

Wrecking Train—N. Y., N. H. & H. R. R.

Although wrecks are much less frequent than formerly, there is now great need of giving careful attention to prompt work when they do occur. There are about 230 regular trains per day on the Boston end of the Providence Division of the New York, New Haven & Hartford Railroad, and as most of this business is handled on two-track lines it is apparent that prompt wrecking service is imperative. Mr. F. M. Twombly, Master Mechanic at the Roxbury shops, has given considerable attention to this subject, and the results which he has attained will interest many of our readers.

The train consists of four cars. The one next the engine is a revolving derrick car built by the Industrial Works, Bay City, Michigan. It has steam lifting revolving and propelling power and its capacity at a radius of 20 feet is 40,000 pounds and at 16 feet 50,000 pounds. It is of the latest model by these builders and weighs 119,250 pounds when in working order. Steam is always kept up in the boiler of the derrick, except when it is being repaired. The fire is looked after by the men who attend to the fires in the engines in the roundhouse, so that the cost is low.

A flat car loaded with two car trucks and one truck for carrying the front end of an engine is placed next to the derrick. This car also carries wrecking frogs or car replacers, levers, pieces of rail, a push car, rail bender, and several ladders. Its weight, loaded, is 40 650 pounds.

The blocking car comes next. It carries a large assortment of blocking of different sizes and also drag ropes, axles, shovels, saws, tools for handling ice and cotton bales, track tools and special tools for interlocking work. A large stock of nails of various sizes and a quantity of track spikes complete the list of important items. This car weighs 51,500 pounds.

The tool car is the last one. It is 60 ft. long, and together with the blocking car is heated by steam, while the whole train is equipped with air brakes. The tool car carries a large variety of implements and appliances, among which the following may be

mentioned: A telegraph outfit for a temporary office, a case of medicines and bandages for emergencies, canvas covers for perishable freight, umbrellas for the protection of passengers, blocks and falls with large and small ropes, extra air hose with fittings attached, ropes and hawsers, spare wire rope for the steam derrick, a large assortment of chains for slings, hydraulic jacks, small screw jacks and other less important things. This car also contains a small office for the Master Mechanic, a commissary and galley outfit for supplying the men with food in case they are obliged to be out for a number of hours. The comfort of the men is also considered by the provision of oilskin suits for them to wear in bad weather. This car carries a great variety of equipment, and it is so neatly arranged as to compel favorable comment. The chains are hung on large hooks, and each hook is marked with the size and length of the chain it carries. A convenient swinging crane is hung at the door through which the hydraulic jacks and other heavy tools are loaded. This facilitates getting the outfit away from the scene of a wreck after the work is completed. The tool car weighs 62,000 pounds.

The train is heavy enough to require a good engine to haul it, and usually a standard eight-wheel passenger engine is assigned for this service. The engine, which was out on the day our representative visited the shops, weighed 172,000 pounds, including the tender. The total weight of the train was 445,400 pounds, or almost 223 tons.

The train, including the locomotive, is always ready to start. One of the spare engines from the roundhouse is run out to the train and stands there instead of in the house until it goes out on its next run. The wrecking crew ordinarily consists of from 15 to 18 men taken from the locomotive and car departments. The foreman is one of the erecting foremen in the locomotive machine shop. This crew is increased to 50 men when necessary. The short time required to get the outfit under way is remarkable. When calls come during working hours the train is ready to start within two or three minutes from the receipt of the notice, and at night this may be accomplished in from 18 to 22 minutes by means of a simple but effective system of calling the crew. The shop signals are given by air whistles and a large bell is rung by compressed air at the roundhouse, all three being operated by the telegraph operator in the Master Mechanic's office. The engine is always assigned and the number known by the dispatcher, which avoids delay in getting train orders, and the whole system works very smoothly. Recently the train was run out for the purpose of exhibiting the preparations by a biograph. The members of the crew were informed in advance in this case and the train was ready to start in 40 seconds after the call sounded.

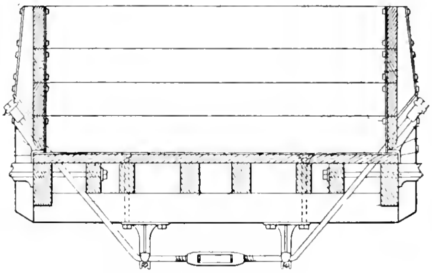
The total cost of maintenance of the equipment in readiness to start is $3.15 per day. This includes the care of the fire under the derrick boiler, the fuel used and the wages of the engineer and fireman who are specially employed at night. These men do other work also and the engine is not figured as adding to the cost because one that would ordinarily stand in the house is run out upon this track.

Combined Stake Pocket and Brace for Gondola Car Sides.

In 1895 a committee reported to the Master Car Builders' Association on the best methods of staying the sides of coal cars with high sides, with the recommendation that this would be best accomplished by using a transverse tie rod across between the sides near their tops, and protecting the rod by placing an angle iron over it, secured at the ends by washers having grooves to fit the flanges of the angle. As an alternate arrangement for use on cars that were likely to be loaded with lumber, the committee recommended extending two stakes on each side near the middle of the car below the siding, and supporting them by castings having a bearing against the hoppers. Another plan has been used which consists in placing two of the stakes on each side in line with the needle beams, and extending these stakes downward to the bottom faces of the beams.

It is generally admitted that side trussing does not answer the purpose at all satisfactorily because of the necessity of using a very shallow truss. Cross rods are decidedly objectionable because of the obstruction which they offer to loading long materials. Several car department officers have been working on the problem, and in the accompanying engraving the method adopted by Mr. C. A. Schroyer, of the Chicago & North Western Railway, is illustrated. This arrangement makes use of double transverse trusses at the needle beams, and the trusses are reinforced by extending the stakes to the bottom faces of the beams, and by using a regular stake pocket in addition to the special stake pockets which are so designed as to brace and enclose the stakes and receive the truss rods as well.

The stake pockets are bolted to the stakes, and the car sides and center and intermediate sills assist each other in carrying the load. The improved stake pockets have eyes for the truss rods and flanges or feet at the bottom fitting over the floor of the



Combined Stake Pocket and Brace.

car. Heels project downward over the ends of the floor plank and the casting also encloses the stake. The position of the lower stake pocket is shown in the illustration. The truss rods are entirely out of the way of the load carried in the car and from extended trials in practice the plan appears to meet the requirements of gondola cars admirably. Many such cars cannot be loaded to their full rated capacity with coal because of the weakness of the sides.

When the load deflects the center and intermediate sills of a car equipped with this bracing the truss rods tighten and some of the load is transferred to the side planking, and aside from the advantages of supporting the car sides a car with this attachment should be stiffer than one built in the usual way. The stake pockets and queen posts are of malleable iron and the posts are formed so as to receive two of the transverse truss rods and also one of the longitudinal rods. The arrangement shown has been patented by Mr. Wm. S. Schroeder. We are indebted to Mr. C. A. Schroyer for the drawing.

The New York City Paint Tests.

An important series of tests on the durability of paint upon metallic structures which are continuously exposed to the weather and to coal gases was commenced in New York during the month of August by Mr. E. P. North, Consulting Engineer of the Department of Public Works. The structure chosen for the tests is a portion of the 155th street viaduct over Eighth avenue, which is also over the tracks of the Manhattan Elevated Railroad, and consequently is continually exposed to the action of locomotive gases. The metal work has been painted and destroyed by the fumes from the engines in less than four years, and it is now intended that a number of paints shall be tried under conditions which will permit of obtaining an accurate record of their staying qualities under the severe requirements imposed. The city is cleaning the portion of the structure where the tests are to be made and to take all of the paint off the sand blast is used and the surface of the metal is left clean and bright.

A girder is assigned to each of 17 different paint manufacturers, and in order to insure against any damage to the cleaned surfaces they are painted immediately after the cleaning is completed. Each concern is allowed about 3,000 square feet of sur-

face consisting of a girder and its floor system on each side to a line half way between the next girders on each side. Any number of coats may be used, and there is no limitation as to color. The paint is applied by each concern, and every possible advantage is offered to each for a fair test of its product. The time required for coating, the chemical analyses of the paints, the covering power and complete data of the work are carefully kept by the engineers of the department, and the results will undoubtedly be very valuable in assisting engineers in the specification of paints for similar purposes. The city will profit by the information obtained, and it is interesting to know that the cost of the test will be about $7,500. It will probably be worth many times that amount to be able to select the best paint.

Communications.

Crank Axles.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL.

Having noticed the reply by Mr. G. R. Henderson to Mr. G. S. Strong's communication in your October issue, and being anxious to obtain all the information possible on the subject of locomotive design, I would like to know what the objections to crank axles are. They are almost universally used on English locomotives. Why can they not be used equally well in American practice?

MERRILL DAVIS.

NEW YORK, October 1, 1897.

[This is a sensible question and one that might well be raised at this time in view of the excellent results which have been obtained abroad in the use of crank axles. We are tempted to reply to the question, but will give readers an opportunity to explain to our correspondent before doing so.—EDITOR.]

Washing Locomotive Boilers.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

I have received a copy of a paper on the washing out of locomotive boilers, which was read at the October meeting of the Western Railway Club, by Mr. John Mackenzie, in which statements are made which I think will be a surprise to many railroad men; unfortunately the paper is very brief, so brief that it does not give us all the information regarding the author's methods of treating waters in washing out boilers that is necessary to a complete understanding of his experience. As I take it, however, he has been treating the waters of one division of the Nickel Plate road with chemicals used in a secondary tank at stations where the water is very bad, and that this method has been fairly satisfactory, but has not given all the results expected from it. The experience of the road, however, seems to be such that they have not lost faith in this treatment.

While these experiments were going on on one division it appears that Mr. Mackenzie was employing the method of washing out boilers thoroughly and frequently, and using blow-off cocks and surface blowers extensively, to prevent the scaling of boilers on other divisions where the water was not so treated, and that where this method was employed he had much trouble from leaky flues; the necessity of turning the power quickly at terminals led him to lengthen the period between the washing out of the boilers, and instead of washing them every 400 miles he finally allowed them to run 7,000 miles between the washings, with the result that the leaking of the flues stopped and the expense of boiler-washers, boiler-makers, etc., was materially reduced; furthermore, when these boilers were washed out at the end of 7,000 miles there appeared to be no more sediment in them than when they were washed out more frequently.

I am not informed as to how long this method of caring for boilers has been in use or whether the large mileage between washings has not resulted in heavy incrustation on the tubes and other heating surfaces. It hardly seems possible that this practice could have been carried out for any length of time without its bad effects being shown by the condition of the boiler. When impure waters are used in locomotive boilers every gallon evaporated leaves a residue in the form of sediment or incrusting material, and furthermore there is no way for this material to get out of the boiler except through the washout holes; we all know that it cannot get out through the cylinders except when the boiler is foaming, and the material thus passing off from the boiler must be very slight; the conclusion, therefore, appears inevitable that if the incrusting matter is not washed out of a boiler it will be found upon the heating surfaces. This is the experience of every one who has had the care of boilers, and how Mr. Mackenzie could have arrived at his conclusions without looking further for the causes which led to his peculiar experience is hard to understand.

A number of Western railroads running through districts where the water is bad have used soda ash successfully in the tender tanks and have saved a large amount of money in boiler work thereby. The use of this soda ash is only successful when accompanied by thorough boiler washing and the frequent use of blow-off cocks. In fact, I have no hesitation in saying that the use of soda ash is a detriment rather than an advantage unless the boilers are washed out thoroughly and frequently; its only office is to keep the incrusting matter in a soft and muddy state and prevent it adhering to the heating surfaces until it can be washed out, and the essence of the whole business is thorough boiler washing. In this connection it may be of interest to note that these roads have, in the past year or two, found out that instead of the temperature of the water used for washing out being the most important thing, it is the use of high pressure that is essential. It is almost invariably the case that where really hot water is used in boiler washing the pressure is very low, so low that it cannot clean the surfaces properly. These roads are now using pressures of from 80 to 100 pounds, and where the work has to be done in a hurry cold water is used. The high pressure forces the scale from the surfaces against which the stream of water is directed, and the fact that the water is cold does not seem to be as detrimental as has been supposed. On the road with which the writer is connected all washout pumps are supplied with pressure regulators and pressure gauges, and it is the intention to have all of them supply at least 100 pounds pressure, and 120 pounds is preferred. This pressure is recorded at the pump, but the supply pipes are of large diameter, and it is believed that the pressure at the nozzle is not greatly reduced by the friction in the pipes. On one division where the water is particularly bad the pressure employed at the pumps is 175 pounds per square inch. Furthermore, our boilers are provided with washout plugs at many more points that is considered necessary on many roads where the water is better; two tubes are left out and washout plugs inserted in their places in the front tube sheet, so that through these openings streams of water can be directed against the adjoining tubes and much of the deposits removed from them. These are in addition to the usual plugs at the bottom of the front tube sheet. Washout plugs are also located so that the crown sheet, side sheets and back sheet can be thoroughly washed, as well as having the usual openings at the corners of the box above the ring.

Boiler-washing takes time, and when engines are hard worked, and must be turned quickly at terminals, the time necessary to properly care for the boilers is a serious matter; but those roads that are compelled to use bad water, and have gone into this method of caring for their boilers, are unanimously of the opinion that notwithstanding the time consumed in boiler-washing the engines can make more mileage and do better service in getting the trains over the road than if this scale is allowed to accumulate in the boilers and the operating and mechanical departments have to struggle against the evils incident thereto. Furthermore, the mechanical departments know beyond question that they are obtaining much longer life from both fireboxes and tubes, and that the cost of boiler repairs is reduced enormously. With such facts as these so well established that they cannot well be controverted, the experience of the Nickel Plate road seems strange indeed.

OCT. 23, 1897. M. M.

Large vs. Small Locomotive Valves.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

The above subject, upon which you printed an article in your October issue, was given considerable attention some years ago. It was reported on and discussed by the American Master Mechanics' Association, as shown by the seventh report (pages 186, 187, 195 and 201). Also the tenth report, (page 13), contains a statement by the Committee on Valves and Valve Gearing, consisting of Messrs. Lauder, Hudson and Waite. The subject was discussed at the same time (page 224). At the eleventh meeting a paper was read by Mr. John E. Martin on "Tests of Passenger Locomotives." On page 162 he gives the result of his experiments. He states that

it is clearly proved in the experiments made with different lengths of port openings that in every case the power developed by the longer port is proved to be the greater, and further it is to be obtained with decreased consumption of steam per horse-power. This result is due to the greater wiredrawing of the steam during admission with the smaller port openings. Messrs. Lauder and Hudson's conclusions are about the same.

These discussions and experiments extended over the years 1874, 1875, 1876, 1877 and 1878, and a number of locomotives were changed and built with the short ports, some 8 and 10 inches long in 16 inch cylinders. It has never been fully demonstrated by the advocates of short ports why better results should be obtained than with long ones, and the matter finally died out, and the short ports were cut out to normal length.

It is very probable that the reason you give why a 16-inch port is better than a 20-inch, "that the area of the admission ports to the earlier cut-off is capable of supplying all of the steam that can get through the pipes or ports," is the true solution.

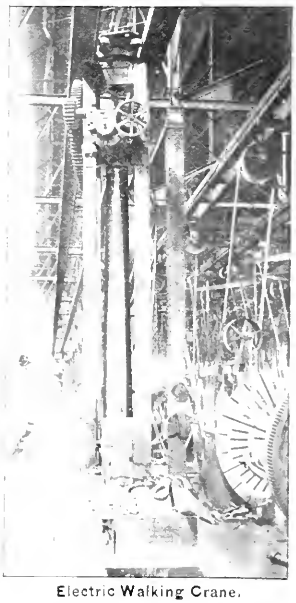
About the time the discussion of long and short ports was at its height the writer had an engine on a fast train that was not doing good work; cards were taken from the engine which showed a low mean effective pressure in the cylinders. After investigation it was concluded that the throttle valve, dry pipe and steam pipes were too small; the steam was wiredrawn from the throttle to the cylinders. These pipes were all replaced with larger ones, and all short turns were eliminated as far as possible. The result was all that could be desired. A number of locomotives were found with the same defects. The opinion was then formed by the writer that the apparent improved results claimed for short steam ports might be due to defective dry pipe, steam pipes or passages, that would admit only enough steam for work in the small port and show no better result with greater port area, the volume of steam being the same.

The deficiency of steam pipe area was very prevalent in old locomotive designs, though the writer found some designed in 1884 that had the same defects, and changed all that came under his supervision with the same improved results. JAMES M. BOON.

UTICA, N. Y., Oct. 23, 1897.

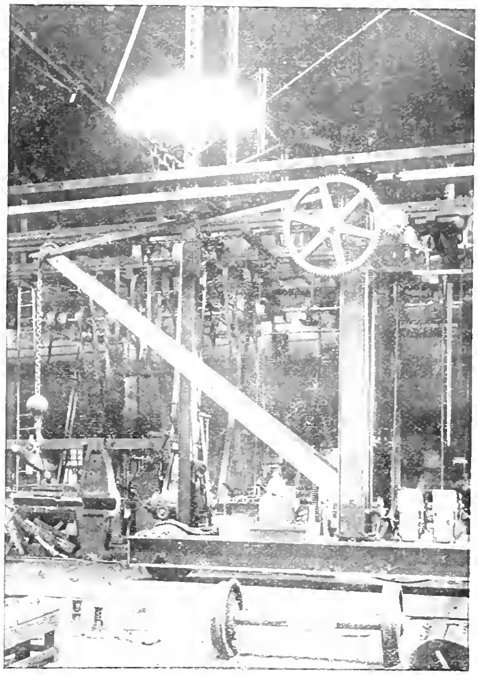
Electric Walking Crane - C. M. & St. P. Ry.

The convenience of electric motors for attachment to machinery which was not arranged with a view of their employment is nicely shown in a design worked out some time ago by Mr. George Gibbs, Mechanical Engineer of the Chicago, Milwaukee & St. Paul Railway at the West Milwaukee locomotive repair shop. The application is to the operation of a walking crane formerly driven by a rope. The crane bears the name of Craven Brothers, Manchester, and has done service for a number of years. The floor carriage is built of I beams, as will be seen by an examination of the engravings showing the side view. These beams are covered at top and bottom by iron cover plates, and within the box thus formed the propelling motor was placed.



Electric Walking Crane.

The mast is also of I beams carrying a small carriage at its top which forms the upper bearing of the crane and runs along a track formed by two I beams turned on their sides and extending the full length of the shop. The crane is located centrally between the machine and the erecting floors and it is kept busy a large part of the time. The motor for hoisting is secured to brackets at the top of the mast and the gearing is clearly shown in the engravings. The motors have separate controllers mounted



Electric Walking Crane.

on the base carriage and they are very compact, taking up little space.

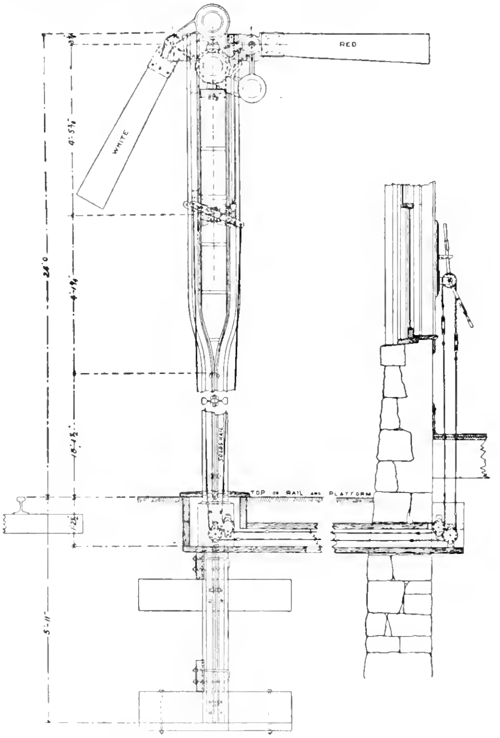
The motors are of the Gibbs type, known as "F 5," and run at 700 revolutions per minute, taking current from overhead wires suspended above the upper rail of the crane. Power is furnished from generators which are always running for other purposes during working hours. Worm gearing is used in both cases, the system of reduction being exceedingly compact and strong, and it is also well-protected from injury in operation.

The most interesting feature of the design is not connected with the details of construction, but is the fact that the rope drive could be so neatly and easily replaced by motors. The crane formerly run by means of a cotton rope which was wrapped around sheaves on the top of the mast between the rails, and gearing was employed to traverse the crane and do the lifting. The rope ran at a very high speed and was kept running all day. It was found that the countershaft and rope consumed 12 horse power when running light and the total power consumed when running the crane at its full capacity was only 15 horse power, which gave three horse power available for doing useful work, a very small proportion. The electric motors are rated at 5 horse power each. As they were applied with very little change in the mechanism the work of applying them was not expensive. The hoisting motor required the addition of one gear and pinion and two small gears were added to connect the traversing motor to the driving wheel. We are indebted to Mr. George Gibbs for the photographs.

Well kept records of maintenace of way on roads of acknowledged high standard will show that only 30 per cent. of the labor cost is in conjunction with the use of new material, while 70 per cent. is expended in maintaining the track to the required standard with the material in use. It must be patent to all, says Mr. H. W. Church in a paper before the Roadmasters' Association, that without a system of accounting for so large a percentage of the labor cost, and knowing that is being judiciously and economically employed, there is a great opportunity for careless and wasteful application.

The Sanborn Train-Order Signal.

Through the courtesy of Mr. S. Sanborn, General Superintendent of the Chicago & Northwestern Railway, we have received a drawing of his improved train-order and block signal which is being used rather extensively on the road mentioned. The object of the arrangement selected was to produce a semaphore signal that would be permanent and do away with the necessity of renewal of the mast every few years, which must be done if wooden poles are used. The drawing shows a front elevation of a double signal. It is constructed of old steel rails of 50 pounds section riveted together flange to flange, and at a distance of about nine feet from the top of the mast the rails diverge, leaving a space of 8⅝ inches between the flanges near the top. The engraving shows the method of attracting the semaphores and also the location of the balance levers. The connection from these



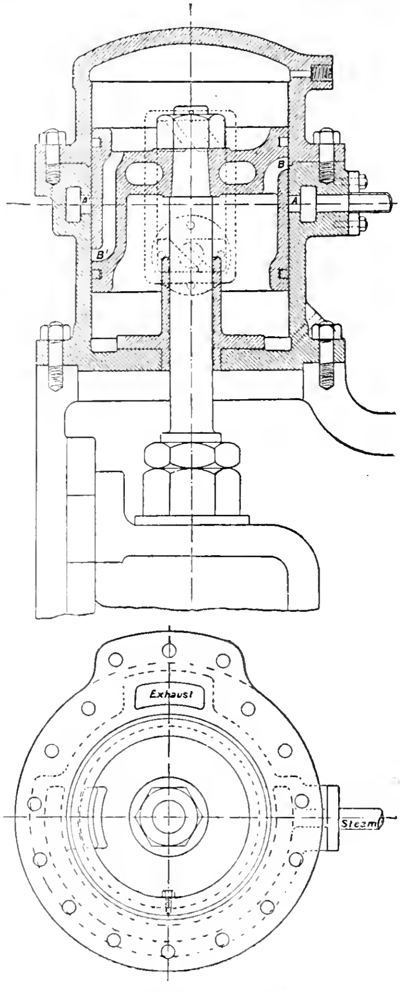
Sanborn's Train-Order Signal.

levers to the operating levers in the station is by wires and chains. To brace the mast laterally anchor planks are secured to it underground and the mast rests upon a plank placed flatwise. The cost of manufacturing the signal is stated by Mr. Sanborn to be $32.00 complete and set up at the station. It is constructed for this cost at the shop of the Chicago & Northwestern Railway. This cost compares very favorably with those of less permanent character, and permanence is an important matter, in view of the large number of signals that this road is to install.

Joy's Assistant Cylinder.

The so-called assistant cylinder designed and patented by Mr. David Joy, the well-known inventor of the Joy valve gear, has attracted considerable attention among marine engineers, and we present herewith an illustration and brief description of it for which we are indebted to *The Engineer*:

The assistant cylinder, as its name implies, assists the driving of the slide valve, and thereby relieves the eccentrics and gear of this work, taking the place of the ordinary balance cylinder, and in some cases, being much smaller than the latter, has been actually placed within the balance cylinder casting. It will be seen that it is practically an engine having admission, cut-off, compression, and release, the piston forming the valve to give the required regulation, while being attached directly to the valve spindle its stroke varies with that of the valve itself, so that when the engines are linked up, the cylinder obtains less steam and only does work proportionate to the requirements of the valve gear, no individual attention being required. In most warships, where the space between the top of the valve chest and the under side of the deck beams is very limited, an arrangement, as shown, i. e., forming the cover joint some way down the cylinder wall, is adopted



Joy's Assistant Cylinder.

with satisfactory results, enabling the cylinder to be overhauled without taking any of the gear apart; in one instance a cylinder having a stroke of 7 inches was fitted within an available space of only 16½ inches. Owing to the rapidly increasing size of engines, combined with higher piston speeds and steam pressures on modern high-class engines, some means of overcoming the inertia of the valves at the beginning of the stroke, and checking the momentum at the end, other than by the eccentrics and rods, has become a pressing necessity, and the assistant cylinder has been designed to meet this want.

The system has been applied to 540,000 indicated horse-power of various classes of engines, among which we may mention 24 ships of the English Navy, and others of the Italian, Austrian, Dutch, Portuguese, Spanish, Argentine, Chilian and Japanese governments, besides many English mail steamers.

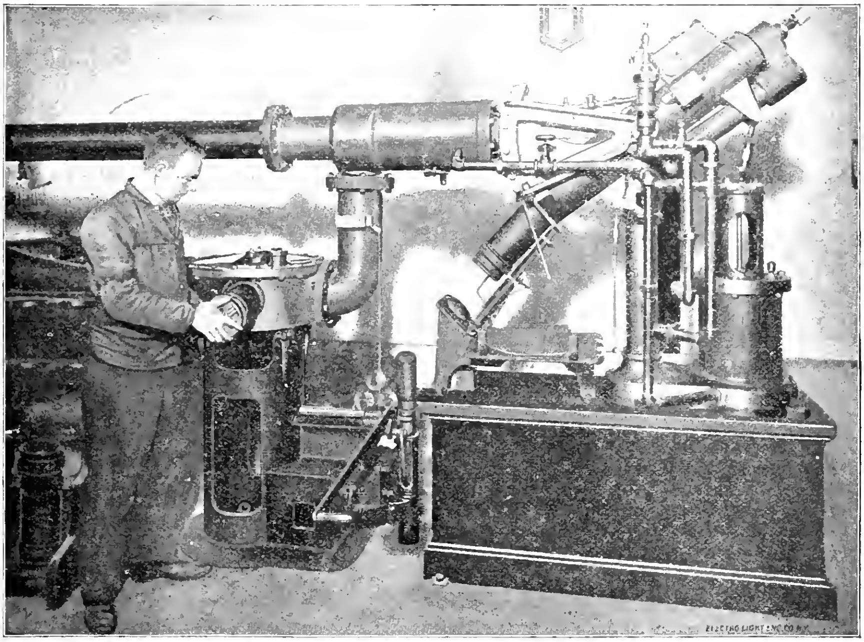
The Pneumatic Tube System of Mail Transportation in New York.

The line of pneumatic tubes for the transmission of mail underground, now operating between the Produce Exchange and the General Post Office at City Hall, New York, is but part of a system of rapid and economical mail delivery which it is expected will eventually extend throughout the limits of New York. It is known as the Batcheller Pneumatic Dispatch Tube System, and was installed by the Tubular Dispatch Company, of New York, under the supervision of B. C. Batcheller, of Philadelphia, Pa., from whom the system takes its name. The actual construction is in charge of Chas. A. Budd, Assistant Engineer, also of Philadelphia.

A general idea of the mail tube system is given by the statement that it consists of a circuit of iron tubes laid underground and through which letters and other mail matter is transported in carriers by means of compressed air. Carriers may follow one another at intervals of about six seconds, which experience indicates is the time required to avoid contact.

In the line opened between the Post Office and the Produce Exchange and which was successfully tested and set in operation Oct. 7th, the tubes are of bored cast iron, twelve feet in length. They have bells cast upon one end in order to join the sections with lead and oakum calked in the usual manner of making joints in the water and gas pipes, except that at the bottom of the bell a counter bore is turned to receive the finished end of the next section. By thus machining the ends a practically continuous tube with no shoulders is formed. A mandrel 18 inches in length and $8\frac{7}{64}$ inches in diameter at the center tapering to eight inches at the ends is run through on completion of each joint. This pipe is laid in trenches from two to six feet below the pavement supported by having the ground firmly tamped about it. The inside diameter of the pipe is $8\frac{1}{8}$ inches which is increases to $8\frac{3}{8}$ inches at the bends. This is the greatest diameter that can be profitably employed without resorting to carriers on wheels.

The route of the tubes, the length of which is 4,000 feet, is through Beekman street to William, to South William, to Broad, to Stone and thence to the Exchange. The power used for transmission is compressed air at a comparatively low pressure. This is supplied by the Rand improved duplex air compressor, built by the Rand Drill Company, of 100 Broadway, New York City, and is located in the basement of the Post Office. The compressor needs no detail description, as it does not differ materially from air compressors of the Rand type built for other purposes. The stroke is 20 inches, the diameter of the steam cylinders 10 inches and the air cylinders 24 inches. Compressed air at a pressure of six or eight pounds per square inch is stored in a tank from which it flows to the sending apparatus, situated on the floor above the compressor. From here the air is sent through the outgoing tube to the Produce Exchange, from whence it flows back through the return tube to the Post Office, passing through the receiving apparatus and into a tank.



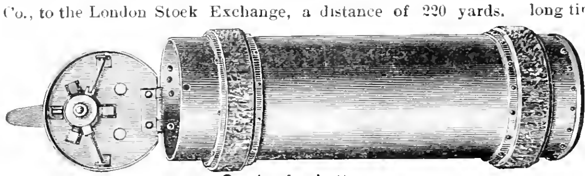
Sending and Receiving Apparatus.

The sending apparatus is simply a valve and consists of a short section of tube supported on trunnions and enclosed in a circular box. This can be turned so as to receive the carrier. It is then turned by a handle until it justifies with the main line of the tube, and the carrier is driven forward at once by the air pressure. The style of receiver depends upon the pressure at the station. If this exists as in the case of the Produce Exchange line, the tube cannot be opened to allow the carrier to come out. In that case the receiver consists of a movable section of tube upon trunnions, and placed normally in a position to form a continuation of the main tube, from which the carriers are received. Just before the carriers reach the receiving chamber the current of the air passes out through slots to a jacket. By a system of air cushions, valves and cylinders the pressure is relieved, and the receiver is tilted to permit the exit of the carrier.

The carrier is a flat sheet of steel bent into a cylinder, riveted and soldered. It is two feet long and seven inches in diameter. The front end is a convex disk of steel, stamped in the desired form, and secured to the body by rivets. A buffer of felt is attached to

the end. The carrier is supported in the tube by two bearing rings made of fibrous woven material, located on the body of the carrier a short distance from each end. These permit it to pass through a bend in the tube of minimum radius without becoming wedged. The rear end of the carrier is closed by a hinged lid and special lock, which insures the impossibility of the carriers opening during transit. The carriers when empty weigh about 12 pounds; when loaded they weigh from 20 to 25. They hold from 600 to 800 letters each.

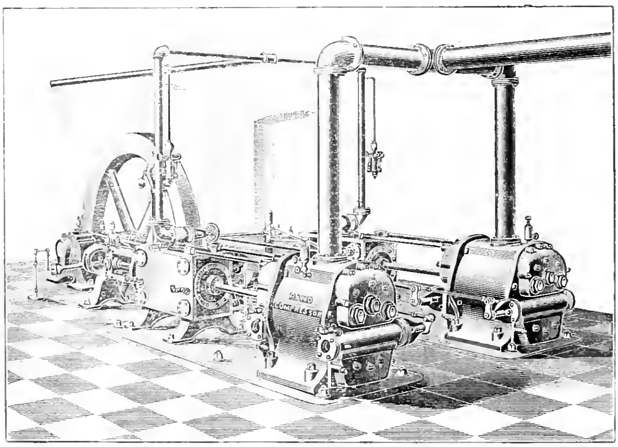
The earliest practical use of pneumatic tubes for transmission purposes of any kind is noted in a system of 1½ inch pipes laid in London in 1853. These were employed for sending telegrams from the central station of the Electric & International Telegraph Co., to the London Stock Exchange, a distance of 220 yards.



Carrier for Letters.

The system at present in use in London is known as the "radial," employing one central and several minor pumping stations from which the tubes radiate. The outgoing tubes were operated by compressed air, the incoming by suction. Three-inch tubes are used. The London system includes 42 stations and 34 miles of tube. Liverpool, Manchester, Birmingham, Glasgow, Dublin and New Castle are also equipped with pneumatic tube systems of transportation. The city of Berlin has an extensive radial system of tubes. In Paris pneumatic tubes were first introduced in 1865.

The first system of pneumatic tubes for transportation of mail in the United States was installed in the city of Philadelphia in



Compressor for Pneumatic Mail Tube System.- By the Rand Drill Co.

1892, and connected the main postoffice with the sub-postoffice in the Bourse. The system now being installed in New York and of which the Produce Exchange line is the beginning, is practically the same as that in Philadelphia. It is essentially an American invention, and except the small tubes used by the Western Union Telegraph Company in some of the larger American cities, is the only organized and successful attempt to introduce pneumatic transportation.

It is the purpose of the New York post office authorities to follow the Produce Exchange line with one to the Grand Central Depot at 42nd Street and another to Brooklyn, and work on these two lines is already far advanced.

The Ashton Valve Works.

The works of the Ashton Valve Company are situated in the business district of Boston, and while they are not impressive as regards size and modernness, they are conveniently arranged on three floors of the building, a part of which is used for other purposes, and it is evident that a large capacity is provided in a small compass. The company manufactures pop safety valves, pressure and vacuum gages with their accessories and the product is of high quality, as an inspection of the works in all its stages shows. The company is very busy with government marine work and locomotive orders; there is enough of the latter work on order to keep the shop running at its full capacity for a long time. The export business is also large.

The heavier machine work and the assembling of the pops is done in the large machine-room on the third floor of the building. Here the large pop castings are bored, and the heavier brass work is done. The top floor is divided into smaller rooms, a foundry, a test room, the boiler and engine plants, the spring room and the gage department. The metal for the brass and composition parts is cast here. The testing of pops is very simple. A special boiler of the locomotive type furnishes steam up to 300 pounds pressure per square inch, if needed, and a 6-inch pipe leads from the boiler-room into the test room where the pops are attached by a nipple. The blowing-off pressure is carefully adjusted, and the reduction in pressure before the closing of the valve is attended to with equal care. The reduction of pressure is made very slight—as little as 3 pounds - and the workmanship and means provided for adjustment must be good in order to admit of this result. The pops are compared with a large special gage that is frequently tested.

The springs are made of square Jessop's steel, and as the life of the valve is largely dependent upon this member, its construction is important. The size of the cross-section of the steel has a marked influence on the working of the spring, and odd sizes with $\frac{1}{32}$ inch variation, more or less, than the standard sizes, are frequently necessary in order to get the desired effect of reliability of popping and small reduction of pressure before the valves seat themselves. As to the life of the springs, it is interesting to know that an Ashton pop valve working under a pressure of 90 pounds has been opened daily by hand since March, 1883 or over fourteen years, without failing to close at the proper pressure, until within a month ago. Such a report was seen at the office of this company, and it was seen to be not an unusual thing for such accounts of the reliability and durability of the valves to be sent in voluntarily by users of them. Another interesting thing was noted, that the two pop valves ordered for the new experimental locomotive at Purdue University for pressures of 253 and 255 pounds are made in all respects like the ordinary valves of these manufacturers. The practice for regular work for ordinary pressures makes use of sufficiently strong construction to admit of carrying these high pressures. This was surprising to our representative, as it was expected that special valves would be furnished on this order.

The most interesting department was the gage-room. The steam gage springs are bent into the proper form from seamless, elliptical, solid drawn tubing which is cut into the proper length. It is filled with sand, the ends are plugged, and it is bent over a die by a roller. These springs must be free from imperfection and after receiving the end fittings, which are soldered on, they are hung up for several weeks before being used. This is to permit the internal stresses from the bending to equalize before the springs are put into gages. The cases and movements are finished, and after assembling a blank dial and the hand are put on. The hand is adjusted at the proper point for the zero pressure and the other points on the dial are found and marked by com-

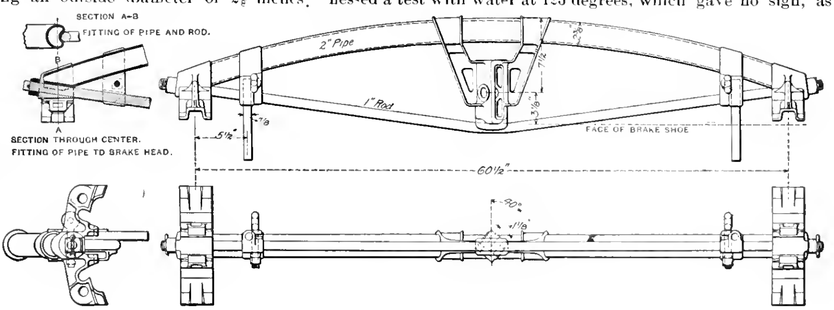
parison with a standard test gage, which, though tested every month, has not been found out of adjustment in four years of continuous service. Each gage spring is calibrated and the dial marks are made to fit the action of the springs. The gages are therefore correct throughout their range instead of at a few points only as must be the case with springs which are put into gages the dials of which have been put in "ready made" with the graduation done beforehand. Here is conscientious work which is worth a little extra cost. The dials are covered with tar after being silvered and stamped and the polishing brings out the bright surface, leaving the lettering and graduation marks in black. For testing hydraulic gages a hydraulic screw test pump with a capacity of 25,000 pounds per square inch is used. This is a block of 4 inch square Jessop's steel with a 1¼-inch hole bored into it, to which the plunger of the screw is fitted. Two nipples take the test gage and the gage to be compared therewith. The vacuum gages are compared with a mercury column and the ordinary pressure gages are tried on a pump tester.

The office, store and drafting rooms complete the plant, which is of special interest because of the long and painstaking career of the company. The attention to small details is shown by the use of a spring stop to catch the movement of the gage hands when sent back to the zero point suddenly, and by the use of German silver sectors for the train line movements of duplex air-brake gages. These movements are subject to sudden fluctuations of pressure, which have been known to strip the threads of brass sectors, and the practice of using German silver has been adopted for all such sectors to the improvement of all gages of this type. Much more might be said about details of construction if space permitted. The officers of the company are as follows: Mr. Edward P. Mason, President; Mr. Fred. A. Casey, Vice-President, and Mr. Albert C. Ashton, Secretary and Treasurer.

The Monarch Brakebeam.

The drawing shown herewith illustrates the method of constructing the Monarch brakebeam, manufactured by the Monarch Brakebeam Company, Limited, Detroit.

The form of this beam is that of the bow string truss. This causes it to draw the shoes away from the wheels when the brakes are released, and it is also claimed that the form of the attachment of the brakehead to the beam prevents the former from turning. The beam consists of a truss the compression member of which is formed in a curve of 2-inch steel tubing having an outside diameter of 2⅜ inches. The tension member is a 1-inch round rod threaded to receive nuts at the ends. The brakehead is secured to the beam by the nuts on the ends of the tension rod and in order to insure these nuts against backing off pins are passed through the ends of the rods. The ends of the compression member are entered into the cavities in the brakeheads, the pipe is pressed or indented around the tension member. The wheel guards are of ⅞-inch rods held in malleable iron castings, which are cast in halves and are held together by an eye bolt and nut. The safety hanger engages the eye bolt and the bolt holds the guard piece by means of a slot in the ⅞ inch bar. The strut is also a malleable casting and is provided with two bearings on the compression member. The engraving gives a good idea of the construction of the beam and the relative location of the point of application of the load and of the pressure against the wheels.



The Monarch Brakebeam.

The Most Economical Steam Power.

The lowest cost of furnishing steam power which we have seen is recorded by Dr. R. H. Thurston in *Science*, who states that $11.55 per year of 3,070 working hours covers the cost reached in the Warren Steam Cotton Mill, Providence, R. I. The engine, designed by Edwin Reynolds, of the E. P. Allis Company, Milwaukee, is cross-compound condensing, rated at 1,950 horse power; cylinders, 32 and 68 inches by 5-foot stroke, making 74 revolutions per minute. The steam pressure is 155 pounds per square inch and the coal consumption is 1.35 pounds per horse-power hour. Heine water tube boilers are used. Coal costs $2.26 per ton.

The following is a tabulated statement:

Fuel per horse power per year of 3,070 hours	$4.70
Labor	1.88
Supplies and repairs	.42
Total operating expenses	$7 00
Interest at five per cent	2.05
Depreciation at five per cent	2.05
Taxes	.41
Insurance	.04
Fixed charges	$4.55
Total cost of power per year	$11.55

The cost account includes the cost of steam used for all purposes, including banked fires, nights and Sundays, and that supplied to the mill. The engine replaces a quadruple expansion engine which was destroyed by fire after seven years of service. It appears that the saving of fuel which may be made by a quadruple as compared with a compound engine is more than overbalanced by its higher first cost, when the engine is run only 10 hours a day and the cost of coal is as low as $2.26 per ton.

Hancock Inspirator Tests.

What may be termed "flexibility" is an exceedingly important feature of boiler feeding apparatus when it is applied in the sense of ability to feed water of varying temperatures and to regulate the amount fed from full capacity to about half that amount, and injectors that will throw water at a temperature of over 125 degrees are not common. The following results of temperature tests made recently at the works of the Hancock Inspirator Company in Boston on one of that concern's locomotive inspirators are satisfactorily vouched for, and are of more than ordinary interest:

Steam pressure.	Temperature feed water.	Temperture delivery.	Gallons per hour.
150 pounds	80 degrees	198 degrees	2,925
150 "	124 "	244 "	2,647

The difference of temperature of 44 degrees did not affect the working of the inspirator in any way, except to change the delivery from 2,925 to 2,647 gallons per hour, a difference of 278 gallons per hour. The higher temperature is not likely to be exceeded by water heated by locomotive feed heaters, but 124 degrees is not the limit of the inspirator, which will work equally well up to 136 degrees. By courtesy of Mr. W. S. McGowan, Jr., Treasurer of the company, a representative of this journal witnessed a test with water at 125 degrees, which gave no sign, as far as the operation of the inspirator was concerned, that the feed water was not cold.

A test was also made on the same inspirator to show the amount of variation between the maximum and minimum capacity at the same temperature of the feed water; 75 degrees, and the same steam and back pressures, 160 pounds. The maximum amount of water delivered was 2,940 gallons per hour and the minimum was 1,575 gallons per hour or a little more than 50 per cent. of the maximum. These tests were all made with an inspirator taken from stock and without any changes in the apparatus.

(Established 1832.)

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

28TH YEAR. 66TH YEAR.

PUBLISHED MONTHLY

BY

R. M. VAN ARSDALE,

MORSE BUILDING......................................NEW YORK

G. M. BASFORD, Editor.

NOVEMBER, 1897.

Subscription.—*$2.00 a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union. Subscriptions for this paper will be received and copies kept for sale by the Post Office News Co., 217 Dearborn Street, Chicago, Ill.*

EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Special Notice.—*As the* AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL *is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 25th day of each month.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* **When a subscriber changes his address** *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

The paper may be obtained and subscriptions for it sent to the following agencies: **Chicago,** *Post Office News Co., 217 Dearborn Street.* **London, Eng.,** *Sampson Low, Marston & Co., Limited St. Dunstan's House, Fetter Lane. E. C.*

Among the advantages obtained from an economizer or feed-water heater is that of greatly increasing the heating surface of the boiler and the saving of heat which would otherwise go to waste. The heating surface thus obtained is better, in the sense of being more efficient, than that of the boiler itself. This is because the circulation in boilers usually keeps all of the water at very nearly a uniform temperature, whereas in an economizer the hot gases as they become cooled are continually brought into contact with still cooler surfaces, so that the greatest possible difference between the temperatures of the water and the hot gases obtains. This effect is best secured by a comparatively slow motion of the water.

It is worthy of note that comparatively little is done to jacket locomotive cylinders, yet it may be done with little trouble and expense. An arrangement for applying asbestos insulation to cylinders, cylinder heads and steam chests was shown in our issue of April, 1896. This is put on in such a way as to permit of removing the cylinder heads and steam chest covers, insulation and all. The apparent advantages of this practice are such as to cause wonder that it is so seldom followed, although steam pipes for stationary plants not exposed to the elements are generally encased in non-conducting coverings. The matter has been considered important enough to warrant appointing a committee to report upon it at the next Master Mechanics' convention and it is well that the subject should be brought up for discussion. This is one of the directions in which locomotive efficiency may be improved without change of design or any other expensive alteration.

Railroad managers seem to be rather backward in appreciating the necessity for providing efficient water cranes at stations. It was formerly not important if a train should be delayed a few minutes while the locomotive tank was being filled, but now every moment saved reduces the cost of operation. To look upon the usually comparatively long stops at stations for water as a necessary evil is to be behind the times, because any road may have water stations from which 3,200 gallons may be run into a tender tank in one and one-half minutes, if they will but build them. Large piping, large water cranes and high tanks are required in order to reduce the delays, and as soon as their importance is appreciated the common practice of using low tanks and small pipes will give place to modern methods. There is a marked tendency to improve water service and it is believed to be well worth while because the loss of time at stations must be made up by hard running, which means expensive running. We shall have more to say on this subject later.

It is well known in steam railroad service that the safety of a train depends very largely upon its ability to stop within a reasonable distance. The air-brake has made it possible to greatly increase speeds without endangering the lives of passengers, and it is difficult to understand why the same appreciation of good braking appliances is not held with regard to street cars. We have before us three newspaper clippings giving accounts of recent accidents which occurred to electric cars through inefficient brakes. It is not to be said that the best of brakes would prevent all collisions involving street cars, but it is clear that with the high speeds now practiced on electric railroads the best possible brakes should be provided. Good practice demands some combination other than chilled shoes upon chilled wheels, yet this is not unheard of among street railroads. Those who have been following the subject of power brakes for steam roads for the past 20 years know how much reliance was placed on the old chain brake, yet this is now used to a considerable extent on cable and electric railroads. The same reasons why brakes should have the utmost possible efficiency hold equally well with street as with steam railroads, and there is no reason why air-brakes should not be applied generally to street cars. At least the best of brakeshoes should be used and a few moments study of the results of tests of the Master Car Builder's Association will convince anyone of the great difference between the various types of shoes. The subject of better braking without regard to first cost ought to be discussed, for at present the street railroads are, in many cases open to the criticism of indifference to the public safety. The speeds long ago outgrew the appliances used for controlling them.

THE NEW PROBLEM IN TRANSPORTATION.

Managing officers of steam railroads have been watching the inroads of the electric lines upon their business with great concern, and it is evident that prompt action must be taken or most of the suburban business will be transferred to the trolley lines.

Ten years ago there was almost no electric traction. Now in the United States alone there is a trackage of nearly 14,000 miles. The increase in revenues is not less remarkable, for we are told by Mr. Wm. J. Clark that a road 30 miles long without increasing its trackage or making any other change except to substitute electric for horse traction, has increased its dividends from $60,000 in 1886 to $800,000 in 1896.

The steam roads desire not only to offset the competition of the electric roads; they also want to derive the benefits now enjoyed by the trolley lines as the fruits of better service. One reason why it has been impossible to compare the cost of operation of steam and electric traction on the same road is the tend-

ency for the electric equipment to stimulate travel and increase the volume of business. This is clearly shown by the reports of the increase in travel between Hartford, New Britain and Berlin over the electric line of the New England Railroad. The last year of the operation of steam on this line showed an average of 750 passengers per day.

The number carried under the new plan at once jumped to high figures; the number for the first week, ending May 30, was 27,507, and for the following week 31,513. In the next week it was 20,000. These figures do not represent ordinary conditions because of the novelty of the line, which had a great influence on the amount of travel at first. The smallest number for a week has been 14,502, and for the week ending October 3 the number was 15,145, which may be taken as fairly representing the average conditions. The increase is due to several influences which are too well understood to require enumeration here.

Even if the present electric lines operating under conditions most nearly resembling those of the steam lines prove themselves to be satisfactory as to cost of operation, few roads are ready to undertake the financial burden of a change of power, but it seems probable that the suburban rapid transit system of the future may be reached by an evolution from present methods. Revolutionary engineering very seldom succeeds in connection with railroads, and there are good reasons for going slow.

In some cases a system which occupies an intermediate position between the present steam and electric methods seems to be necessary, and several roads are now seriously considering the adoption of such a plan. Steam appears to be the most natural power for this service, and a revival of the steam dummy is a strong probability. It is necessary to divide the power into small units with a proper regard to the proportion of paying and non-paying weight and the steam motor car recommends itself in these particulars. A motor car with accommodations for 60 passengers would permit of handling the business during the hours of light traffic, and during the busy hours, by giving the engine power enough, trailers could be added for the heavier travel. It is not believed that the resources of the steam locomotive for such service have been exhausted, and the efficiency of finely divided steam power ought to be known before going extensively into changes involving the expense of electric work.

Steam motor cars are now under construction for trial on three different railroads, and while there is nothing new in the idea itself, its application at this time is for the purpose of meeting conditions which have recently arisen. One of these designs is shown elsewhere in this issue. It is evident that trunk-line methods, with large trains, expensive to operate, are not now applicable to a large proportion of suburban and branch line travel. Train crews of five or even six men to care for the transportation of about the same number of passengers are found during hours of light travel on many runs. Herein lies an advantage to any equipment which would necessitate but two men for a motor car and three men for a train of three cars.

The flexibility of a steam motor car service appears to be satisfactory, and in some respects it is even greater than that which is so strongly urged as a recommendation for electricity. The advantage of being able to move the power and concentrate it on any particular line is important, and self-contained power may also be moved bodily for use elsewhere when traffic become dense enough and steady enough to require a central station.

The design of a steam motor car is not an easy problem. It should require the minimum of personal attendance. It should be compact and powerful enough to move itself and three or even four trailers. It should be able to start quickly and to run fast enough, say 40 miles per hour with a full load, and yet should be fairly economical when lightly loaded. There must be fuel and water capacity for runs of 25 or 30 miles. There must be no vibration or oscillation of the motor car by the engine, and comparative noiselessness is desirable.

The power of acceleration should be equal to attaining a speed of say 40 miles per hour, within a distance of from one-third to one-quarter of a mile. This ought to be possible with a weight of about 15,000 pounds per driving wheel and wheels of 50 inches diameter without demanding too much of the boiler.

Much more than a mere question of motive power is involved in this problem. It is a combination of power and business questions and is worthy of the best thought and study that can be brought to bear upon it.

Since the foregoing paragraphs were written, the annual report of the New England Railroad has been published, in which Mr. C. Peter Clark, General Manager, who is to be considered as a pioneer in this experimenting, presents his views on this subject, which we are glad to quote as follows:

The management is alive to the necessity for some method of handling passenger business at less expense per train-mile than appears possible under existing conditions, not only in localities which require a stated passenger service, although furnishing less than a carload of passengers for each train, but also in competition with electric street railways.

A combined engine and car recently designed may meet the first requirement, while the demand of short distance travelers for frequent service may best be met by the use of electricity.

The competing lines of electric cars between Boston and Dorchester (five miles) are responsible for a loss of more than 350,000 passengers during the year.

The local passenger earnings have been suffering for several years from these changed conditions, which threaten increased loss in future.

The passenger business between Hartford and New Britain over this road has for some time averaged 750 passengers per day. It was likely to be entirely lost to the company by the construction of a parallel electric trolley line between the two points. Arrangements were therefore made for a supply of electricity from a station erected by the New Haven Road at Berlin, a third rail was installed by this company on its eastbound track between New Britain and Hartford, and since May 24, 1897, a half-hourly service has been offered the public at a uniform rate of 10 cents. During the 16 weeks following May 24, and ending Sept. 12, the travel on electric road amounted to over 300,000 instead of about 75,000 as would normally have been carried by steam.

If the operation of the third rail proves as satisfactory during the winter as since its installation, an extension of the service to Forestville or Bristol would seem to be clearly desirable.

STEAM-PRESSURE, THROTTLING AND EXPANSION.

The mere mention of the old, old story of the so-called throttling vs. reverse lever regulation of locomotives may cause a "tired feeling" among our readers, but a subject is never old while a new idea may be had from it. Some men have recently discovered that there is something in the idea of throttling and have received much undeserved credit for acknowledging that they were wrong when for years they taught that the wide-open throttle and regulation of speed by the reverse lever was the most economical way to run a locomotive. There are many who hold yet to the opinion that throttling is wasteful, and among them is an exceedingly able engineer, who has said: "It is strange that motive power departments will design valve gears of the most improved pattern and then permit the steam to be distributed by the throttle." He would regulate by the cut-off at all times; others admit that there are conditions of running under which throttling is permissible, and yet others believe that throttling always leads to the saving of steam. If we did not already know that the locomotive is very little understood this difference of opinion would be convincing of that fact. This is a question upon which it is easy to be mistaken; no one knows positively where, under the conditions of common practice, throttling should begin. The reason is probably to be found in the wide variations in the work required from this type of engine, which demand corresponding changes in the method of operation. It is clear that one method is not to be applied equally well under all of the conditions. It is safe to say that the effect upon the steam of the wide range of temperatures in a cylinder working with short cut-off has been underestimated, and it is to this important matter that attention should be drawn, because cylinder condensation is the root of the whole subject, and it seems possible that an important improvement in locomotive operation

may result in this discussion. By the way, the same old subject was discussed as early as 1850, and the authorities of that day appear to have known as much about it as do those of to day. It is strange that history repeats itself so often in locomotive practice and that educated engineers are obliged to learn to-day, as they did nearly 50 years ago, from the relatively uneducated men who handle the engines.

Isherwood in 1863 clearly showed his appreciation of the effect of cylinder condensation, the losses from which he placed as high as from 30 to 40 per cent. In 1851 D. K. Clark experimented on locomotives, and in the preceding year he showed that English locomotive runners had been in advance of the educated engineers of the time. In those days, with about 100 pounds boiler pressure, it was difficult to get the men to use a cut-off of less than one-third of the stroke. It is not necessary to cite the authorities who have become convinced that throttling is sometimes advantageous, but it is worth while noting that Charles T. Porter has recently expressed his opinion in comparing methods of governing stationary engines as follows*: "It has appeared to me that an opening presented itself for a large improvement in the direction of economy by employing a fixed point of cut-off, suitably selected and regulating by means of a throttling governor, thus avoiding early cut-off entirely. There can, I think, be no doubt that though the theoretical gain by cutting off earlier is considerable, this is out-weighed many times over by the increase in the losses from cylinder condensation and waste room.' The object of governing is to adjust the power to a variable load, and the losses of an underloaded engine are well known to be high. It would appear to be a good plan to vary both the cut-off and the steam chest pressure in accordance with the load in such a way as to avoid the higher rates of expansion which cause great differences of temperature between the incoming and the outgoing steam.

There is a difference of 158 degrees Fahrenheit between the temperatures of steam at 175 pounds admission pressure and 2 pounds back pressure, and this difference is only 32 degrees less than the difference between the temperatures of boiling water and ice. If boiler pressures in locomotive practice increase above 200 pounds, which is now believed to be the highest in use in this country for single-expansion engines, the disadvantages of working at high rates of expansion will be yet greater. That there are advantages in higher pressures than are generally employed, and that these are to be had from simple engines, we believe to be true. There is no question about the improvement obtained from high pressures coupled with multiple expansion, but motive-power men are not generally so sure about high pressures in simple engines, owing to the high terminal pressures which follow higher initial pressures. If the cut-off is short enough to prevent this, trouble occurs at once. After considerable study of the subject the conclusion was reached that a material gain might be secured by the use of much higher pressures than are now found even in compound locomotives, and at the same time by throttling the steam down to an admission pressure that would be suitable for the load and the speed of the engine. This is a radical suggestion, but it seems to be good engineering, and we offer it for consideration.

The proposition we make is that boiler pressures of 250 pounds per square inch be used on locomotives and the pressure be reduced to 175 pounds or thereabouts for use in the cylinders. We believe that this may be done by a reducing valve without any disadvantage. This means simply that the well-known advantages of super-heated steam may be applied to locomotives without any change in design except what is necessary to render the boilers strong enough for the additional pressures. Some may say that this will increase the weight of boilers and that present forms cannot be made to stand the pressure. We do not believe that these are to be considered serious objections. There are those who think the present locomotive boiler likely to give place to some form which will do away with the bad features of current practice in the use of stay-bolts, and we have only to look at marine practice to see furnace construction that has been modified to accommodate increased pressures. We do not know of a single important objection to corrugated fireboxes of cylindrical form for locomotive boilers, and it is well known that they withstand high pressures in marine work.

It is entirely unnecessary to explain the reason for obtaining superheating by throttling, as this is well understood. Good use is made of this principle in marine engineering with particular reference to water-tube boilers. Water-tube boilers are often worked at a pressure of 250 pounds and the working pressure at the steam chests brought down to a lower pressure by reducing valves. This appears to be a most direct and simple way of superheating and it would cost very little to ascertain its value.

The real question of throttling seems to us then to be much deeper than one concerning the best way of running a locomotive. It is easy to show conclusively that throttling with present pressures is often better than the other method of regulation; but aside from the mere matter of operation, it seems probable that by carrying throttling a long way farther an important advance step in locomotive engineering may be taken.

* Trans. A. S. M. E., Vol. XVI., p. 113.

AIR BRAKES WILL NOT OPERATE WITHOUT AIR PRESSURE.

A peculiar accident occurred to the New York, New Haven & Hartford 9 a. m. train from New York to Boston, on the morning of September 29, from which some exceedingly important lessons with regard to air brakes should be learned.

This train stopped as usual at Bridgeport and, according to the newspaper accounts, when the engineer tried to slacken speed running into New Haven, preparing to stop, he found that the air-brakes would not work. The speed was high and though the whistle for brakes was sounded, the train was not stopped until t had collided with an engine standing beyond the station which caused the wreck that resulted in the death of the engineer.

Knowing that the air-brake apparatus of the Westinghouse make, which was involved in this accident, does not usually fail to do what is required of it, a representative of this journal looked up the matter carefully and ascertained some facts from employees of the road. He satisfied himself that there is no cause for anxiety about the apparatus, it being clearly not to blame for the trouble, and the importance of the matter renders it desirable that the facts should be published.

A bad leak developed in the front end of the boiler very soon after the train left New York, and it became so bad as to run the steam pressure down enough to cause the train to run into Bridgeport late, and this undoubtedly led the engineer to use every resource to save steam in order to make up the loss. There is every reason to believe that he shut off the air pump in order to save the steam consumed by it, and that he forgot to start it again before the pressure in the brake system was so reduced as to render the brake inoperative. The failure of the governor might cause the pump to stop, but the governor and the pump were set up and tried after the accident and were found to be in perfect order, leaving no doubt that the pump was shut off. That there was no pressure on the train line was shown by the fact that several of the conductors' valves in the cars were opened in response to the whistle signal from the engineer, but there was no exhaust from any of them, which would indicate that the pump had been stopped for some time. It seems probable that it was stopped before the train reached Bridgeport, because some trouble in releasing the brakes on pulling out of that station was reported.

It is customary for engineers to slacken speed before running upon the trestle in approaching New Haven, in fact a rule of the company requires it, but it is clear that this precaution was omitted or the low pressure would have been discovered so that the pump could be started in time. Opinions differ as to the speed of the train in approaching New Haven, but it must have been high, and this was undoubtedly due to the effort to gain the lost time, the down grade toward New Haven having contributed somewhat. The train men were reported to have taken no notice of the signals of the engineer, but that is not true as in

accordance with instructions several of the conductors' valves were operated as stated. There was then, however, no time for the hand brakes to be worked.

The responsibilities which are placed upon air-brakes are enormously increased under the present pressure for rapid traveling and automatic apparatus which will unfailingly work will never be devised as long as human agencies are required for operating them. The best that is to be had is to surround men with good apparatus and to provide warnings to show when it requires attention. This accident did not occur with a careless man. He was trusted and trustworthy and was doing what he considered to be for the interests of his employers. He "forgot."

Since the cause of this accident became known it has been suggested that warning devices should be attached to the air-brake system whereby the engineer would be notified if for any reason the air pressure should become dangerously reduced. It appears to be a very difficult matter to devise an attachment of this kind that would not add to the dangers. Eternal vigilance seems to be the only satisfactory remedy, and this involves an examination and a trial of the apparatus often enough to insure against dangerous conditions. A warning attachment would very properly be relied upon by the engineer, and unless it could be so arranged as to be operated frequently it would be an element of danger.

NOTES.

The new Knapp roller boat recently tried in Toronto Bay makes 6 instead of 60 miles per hour.

A committee of the Board of Trade (England) is still at work upon the investigation of the causes for the breaking of the rails that caused the derailment at St. Neots in 1895.

The Union Elevated Loop Railway in Chicago was opened to the traffic of the Lake Street Elevated trains on Sunday, October 3. The other roads are not yet operating trains over it, but it is expected that it will be in complete use within a few weeks.

The Chippewa Valley Electric Railway, a line 22 miles in length, which was recently described by Mr. C. A. Alderman in a paper before the Civil Engineers' Society of St. Paul, has contracted for power for a term of 20 years at a rate of $6 per horse power per annum.

A report upon bridge warnings for low overhead structures by a committee of the Association of Railway Superintendents of Bridges and Buildings recommends the vertical rope system, as it has been designated, as the best for use under most circumstances. There are numerous modifications of it in detail, but the general principles remain the same.

A committee of the Association of Railway Superintendents of Bridges and Buildings recently reported to the effect that where four stoves are required to heat a building, and would burn about 30 tons of coal per year, the same heating effect may be produced by means of a hot water system, with a consumption of about 12 tons per year, giving a saving of about 18 tons of coal per year.

At the sixteenth annual convention of the American Street Railway Association, at Niagara Falls, on Tuesday, a paper on "Municipal Ownership and Operation of Street Railways" was read by P. F. Sullivan, of Lowell, Mass. The conclusions reached by the author were that municipal administration in American cities was so extravagant and unbusinesslike that, in the interest of the public, the powers and duties of municipalities should be reduced rather than enlarged.

In speaking of the success of the third rail electric application between Hartford and New Britain, President Clark, in the annual report of the New England Railroad, said that it had been operated since May 24 1897, and its efficiency had been such that the company may extend the third rail toward Bristol the coming year. Frequent and rapid communication certainly develops suburban travel, and electricity seems to be the best and most economical power for this purpose.

Japan is not only building more ships than any other power, says Charles H. Cramp in *The North American Review*, but she is building better ships in English shipyards than England herself is constructing for her own navy. While other nations proceed by steps Japan proceeds by leaps and bounds. What other nations are doing may be described as progress, but what Japan is doing must be termed a phenomenon. Comparison with the current progress of other powers discloses the fact that Japan is second only to England in naval activity, being ahead of France, much in advance of Germany and vastly in the lead of Russia and the United States. It must also be borne in mind that the new Japanese fleet comprises throughout the very latest and highest types of naval architecture in every respect of force, economy and efficiency.

An acceleration test of the Sprague electric system, to be used on the South Side Elevated Railroad of Chicago, was recently made at the works of the General Electric Company at Schenectady, N. Y. The car was equipped with four 50 horse-power motors, one on each axle, which made every wheel a driving wheel. The weight of the car was about 24 tons. The test was made with one car, and gave the following results:

Seconds of elapsed time.	Miles per hour.			
5	14	16	18	19
10	26	28	29	30
15	31	31	31	35
20	35	38	37½	38
25	37½	40	39½	40½
30	29½	41	41	..

The ratio of the gears was 1 to .54, and the acceleration was obtained without excessive jerking.

Our navy has now five torpedo boats, and with the new ones now building the number will soon be 21. Last year England had 256, France had 244, Russia, 185; Germany, 155, and Spain, 46. England has 28 torpedo vessels under construction, each of which is required to attain a speed of 30 knots. We have gained by delay in entering this field, as Benj. Micou shows in the *North American Review*, on account of the great expense of the experimentation; but there is nothing to be gained by further delay in the development of this arm of the service. Armor and guns keep up a close race for supremacy, but because of their destructive character nothing is more demoralizing to an enemy than torpedos. Mr. Micou shows that, by taking recent bids as a basis of estimate, some 25 30-knot torpedo boats or 20 or more torpedo-boat destroyers may be built, including their armor and armorment, for the cost of a single complete battleship.

The new Camden Station of the Baltimore & Ohio Railroad was opened for business Oct. 10. It is practically an extension of the old Camden Station which was built in 1857, and which for 40 years has been the principal passenger depot of the Baltimore & Ohio in Baltimore. The increase of business necessitated the erection of a train shed 630 feet long and 82 feet wide, with five tracks for the use of the local and suburban trains. This shed is constructed alongside of the "cut" that leads to the south portal of the Baltimore Belt tunnel, and in the center of this "cut" has been erected a train shed 350 feet long and 42 feet wide for the exclusive use of the Royal Blue Line trains between Washington, Baltimore, Philadelphia and New York. These trains have hitherto backed in and out of Camden Station, but under the new arrangement will make but one stop at Camden. The passenger trains will be pulled through the tunnel by the 95-ton electric motors, thus entirely eliminating smoke from that tunnel. New waiting rooms, restaurant, ticket offices, etc., have been constructed, and altogether the new station is very roomy and exceedingly convenient. The improvements cost about $100,000. The old station will be used for freight.

A good idea has been worked out on the Boston & Maine Railroad in connection with the care of tools used on the locomotives, and after about a year's experience it appears to answer very well. Each engineer is supplied with a set of tools consisting of a hand hammer, a soft hammer, monkey wrench, small screw wrench, screw driver and spanners. These are packed in a wooden box about 19 by 8 by 4 inches in size, furnished

with a malleable-iron handle and corner pieces. The box is like a small tool tray with covers. The tools fit in sockets of malleable iron screwed to the bottom of the box, and covers hinged at the side meeting at the center complete the outfit. Provision is made for a small padlock and the whole affair is convenient and light. It is small enough to be carried in the cab without being in the way. The plan was settled upon by consultation among the master mechanics of the road, and as the boxes cost only about 75 cents and save one-half the expense of engine tools the investment must be considered a good one. Experience has shown the officers of this road that the chief object to be sought in regard to the preservation of small tools is to so watch the tools as to know what becomes of them. These boxes are in charge of the engineers and do not belong to the engine equipment. They are examined regularly and lost or broken tools are replaced at the expense of the company when the loss is explained.

Personals.

Mr. W. A. Love has resigned as Master Mechanic of the Chattanooga, Rome & Columbus.

Mr. J. M. Percy has resigned as Master Mechanic of the Cincinnati & Dayton, at Cincinnati, O.

Mr. A. Fenwick, Master Mechanic of the Green Bay & Western Railroad at Green Bay, Wis., has resigned.

Mr. Charles M. Hays, formerly General Manager of the Wabash Railway, has been elected President of the Grand Trunk.

Mr. J. T. McBride has resigned as General Manager of the Duluth, Missabe & Northern, and the position has been abolished.

Mr. J. T. Rickman has been appointed General Manager of the Hendersonvile & Brevard, with headquarters at Hendersonville, N. C.

Mr. J. B. Gannon has been appointed Master Mechanic of the Southern railway at Louisville, Ky., in place of Mr. V. B. Lang, resigned.

Mr. E. M. Roberts has been appointed Assistant Superintendent and Master Mechanic of the South Atlantic & Ohio Railroad, with headquarters at Bristol, Tenn.

Mr. W. P. Raidler, Master Mechanic of the St. Louis & Hannibal, has resigned to accept a similar position on the Green Bay & Western, with office at Green Bay, Wis.

Mr. George Edward Mann, who for the past five years has been Chief Engineer of the Grade Crossing Commission of Buffalo, died in that city on Saturday, October 1.

Mr. S. R. Callaway, President of the Lake Shore & Michigan Southern, was chosen President of the Pittsburg & Lake Erie also at a meeting of the directors Sept. 22.

Mr. A. J. Ball has been appointed Assistant Superintendent of Motive Power and Machinery of the Cincinnati, Hamilton & Dayton, with headquarters at Cincinnati, O.

W. C. Buly has been appointed Master Mechanic of the Wabash shops at Decatur, Ill. He is succeeded as foreman of the Wabash shops at Delray, Mich., by Mr. Herbert K. Mudd.

Mr. W. J. Sherman has resigned as Chief Engineer, and the office has been abolished. Mr. Frank E. Bissell and Mr. A. S. Bretherton have been appointed Assistant Engineers.

W. H. Rice has been appointed Master Mechanic of the Michoacan & Pacific, with headquarters at Zitacuaro, Mex., in charge of the motive power department, to succeed H. A. O'Brien.

Mr. W. B. Baldwin has been appointed Master Mechanic of the McComb City shops of the Illinois Central, vice Mr. F. C. Losey, transferred. Mr. Baldwin was formerly General Foreman at New Orleans.

Mr. W. H. V. Rosing, late Master Mechanic of the First Division of the Denver & Rio Grande, has been appointed Mechanical Engineer of the Illinois Central at Chicago, to succeed Mr. H. A. Fritz, resigned.

Mrs. Allen, widow of Horatio Allen who had the honor of introducing the first locomotives in this country, died at Hotel Albert, in New York, Oct. 5, aged 87 years. She leaves a son and three daughters.

Mr. Joseph Wood, Fourth Vice-President of the Pennsylvania Lines west of Pittsburgh, has been chosen Third Vice-President to succeed John E. Davidson, deceased, and the office of Fourth Vice-President will be abolished.

Mr. H. A. Fritz has resigned as mechanical engineer of the Illinois Central to accept the position of Mechanical Superintendent of the Universal Car Bearing Company, with office at 1430 Old Colony Building, Chicago.

Mr. J. T. Robinson has been appointed Master Mechanic of the Anniston Division of the Southern Railway at Selma, Ala., in place of Mr. T. M. Feeley, transferred. He was formerly foreman of locomotive repairs at Macon, Ga.

Mr. J. W. Brown, President and General Manager of the Annapolis, Washington & Baltimore, has also been chosen President and General Manager of the Baltimore & Annapolis Short Line, to succeed Mr. J. S. Ricker, resigned.

Mr. J. T. Blair has been appointed General Manager of the Colorado & Northwestern, which is under construction from Boulder to Ward, Colo. He was formerly General Manager of the Pittsburg, Bessemer & Lake Erie.

Mr. A. McCormick has resigned his position as General Foreman of the machinery department of the Chicago, Rock Island & Pacific at Goodland, Kan., to accept the position of Master Mechanic of the Chicago & Alton at Slater, Mo.

Mr. H. D. Galbraith, formerly Master Mechanic of the Fort Worth & Rio Grande, has been appointed Foreman of the machinery department of the St. Louis Southwestern at Texarkana, Tex., to succeed Mr. W. C. Mitchell, resigned.

Mr. John E. Minetree has resigned his position with the Allison Manufacturing Company, of Philadelphia, and become connected, as representative, with the National Tube Works Company, of McKeesport, and Burnett Company, of New York.

Mr. Peter E. Studebaker, Second Vice-President and Treasurer of the Studebaker Brothers Manufacturing Company, of South Bend, Ind., and Vice-President of the Chicago & South Bend Railroad, died at Alma, Mich., Oct. 9, at the age of 61 years.

Mr. C. H. Quereau, General Foreman of the Burlington & Missouri River, at Plattsmouth, Neb., has been appointed Master Mechanic of the first division of the Denver & Rio Grande, with headquarters at Denver, Colo., to succeed Mr. W. H. V. Rosing, resigned.

Mr. J. W. Hall, Foreman of Locomotive Repairs of the Mexican National at the San Luis shops, has been appointed Master Mechanic of the San Luis Division of that road, with headquarters at San Luis Potosi, Mex., to succeed Mr. W. F. Galbraith, transferred.

Mr. John S. Lentz, formerly Superintendent of the car department of the Lehigh Valley, has been appointed Assistant Superintendent of Motive Power. His headquarters will be at South Bethlehem, and he will continue in charge of all car work and the car shops.

Mr. W. F. Galbraith, formerly Master Mechanic of the San Luis Division of the Mexican National, has been appointed Master Mechanic of the Southern Division of that road, with headquarters at the City of Mexico, relieving Mr. J. F. Roberts, Acting Master Mechanic.

Mr. W. G. Purdy, Second Vice-President of the Chicago, Rock Island & Pacific, was chosen First Vice-President of that company Sept. 22, to succeed Benjamin Brewster, deceased, and Mr. W. H. Truesdale, heretofore Third Vice-President, was chosen Second Vice-President.

Mr. V. B. Lang, who recently resigned as Master Mechanic of the Southern Railway at Louisville, Ky., has been appointed Master Mechanic of the Southern Division of the Cincinnati, New Orleans & Texas Pacific, with headquarters at Chattanooga, to succeed P. H. Schreiber, deceased.

Mr. E. M. Humestone, who has been Master Mechanic and Assistant Superintendent of the Philadelphia, Reading & New England since Jan. 1, 1894, has resigned on account of ill health, and after spending several months in traveling will make his home at Hartford, Conn. He has been succeeded by Mr. H. Schaefer.

Mr. David Patterson, Master Mechanic of the Southern Division of the Kansas City, Pittsburgh & Gulf, has been transferred to the Northern Division, with headquarters at Pittsburg, Kan., to succeed E. Dawson, resigned. J. B. Stubbs, formerly General Foreman of the Union Pacific, succeeds Mr. Patterson at Shreveport, La.

Mr. W. J. Sherman has tendered his resignation as Chief Engineer of the Wheeling & Lake Erie. He was formerly Chief Engineer of Roadway, Bridges and Buildings of the Louisville, Evansville & St. Louis, and afterward held a similar position on the Gulf, Colorado & Santa Fe. The office of Chief Engineer will be abolished.

Mr. F. E. House, heretofore Chief Engineer of the Pittsburg, Bessemer & Lake Erie, has been appointed General Superintendent of that road, with headquarters at Pittsburg, Pa., effective Oct. 1, and the office of Chief Engineer has been abolished. He will have charge of the department of transportation, machinery and maintenance of way.

Mr. W. C. Mitchell has resigned as foreman of the motive power and car department of the St. Louis Southwestern, at Texarkana, Tex., to accept the position of General Superintendent of the Lima Locomotive and Machine Works, at Lima, O. He has been connected with the St. Louis Southwestern in various capacities for five years.

Mr. W. A. Stone has resigned as Master Mechanic of the Birmingham division of the Southern Railway at Birmingham, Ala. He has been located at Birmingham since last July, and was formerly for six years Master Mechanic at Selma, Ala. From October, 1885, to May, 1891, he was Master Mechanic of the Louisville, Evansville & St. Louis. He has been succeeded by Mr. T. M. Feeley, formerly Master Mechanic at Selma, Ala.

Mr. William B. Bement, for many years the head of the manufacturing firm Bement, Miles & Co., died suddenly Oct 6 at his home. Mr. Bement was 80 years old and a native of Bradford, Merrimac County, New Hampshire. He early learned the machinists' trade, and at the age of 19 was a member of the firm of Moore & Bement, in Peterborough, New Hampshire. He afterward founded the concern which finally became Bement, Miles & Co.

Mr. George M. Pullman died at his Chicago home Oct. 19 from heart disease. He was born March 3, 1831, in Brocton, N. Y. His life work was the building of the business of constructing and operating sleeping cars and the establishment of the large works in connection therewith in the suburbs of Chicago, the town thus brought into existence being named for him. His business sagacity and executive ability enabled him to secure a large fortune and to very materially improve the conditions of comfort in railroad travel.

Captain Peter Hogan, widely known as a civil and consulting engineer and one of the first to advocate the building of a ship canal at Nicaragua, died at his home in Ballston Spa, N. Y., Oct. 10, in his seventy-first year. Captain Hogan was prominent in the work of the preservation of the health of the great cities by planning for the supplies of pure water and the disposal of sewage, and his opinions on these subjects were frequently printed in health and scientific journals. He constructed the Duncan Company's mammoth stone dam across the Hudson River at Mechanicsville in 1877-8, and since then has been engaged on plans for the deep sea disposal of the sewage of New York City. At the time of his death he was employed as consulting engineer in the construction of the new city buildings on Ward's Island. Captain Hogan was in the engineering department of the Philadelphia & Reading Railroad when the Mexican war broke out, and served as a Lieutenant from Vera Cruz to the City of Mexico.

Books Received.

A Field Manual for Railroad Engineers, by J. C. Nagle, M. A., M. C. E., Professor of Civil Engineering in the Agricultural and Mechanical College of Texas. 12mo, morocco flap, $3. New York, 1897: John Wiley & Sons.

New Publications.

Universal Directory of Railway Officials, 1897. Compiled from official sources by S. Richardson Blundstone, Editor of *The Railway Engineer*. The Directory Publishing Co., 8 Catherine street, Strand, London. Price, 10 shillings.

We have published notices of earlier editions of this directory. The present edition has been revised and brought up to date with some additions, such as the Selangor and the Perak State railroads; light railroads on the Continent, African, Japanese, Chilian and Siberian roads, and also a much larger number of roads in the United States are included. Twenty-six pages represent the additions in this part of the book. The directory is found to be exceedingly valuable and convenient by those having occasion to correspond with foreign railroad officials.

American and Other Machinery Abroad. By Fred J. Miller, Editor *American Machinist*. The American Machinist, New York, 1897.

This little book of 90 pages is a study of the European field for the introduction of American machinery, and the substance of its contents appeared as correspondence to the *American Machinist* from the pen of Mr. Miller while he was traveling in Europe. It contains his impressions gathered during a tour among foreign machine shops in which machinery is built and used, and it shows how such shops are conducted, and gives special attention to the conditions which must be met by American machine tools in those countries. It is an interesting and instructive presentation of the subject, and will be valuable to those who are engaged in exporting machinery.

The Railway Magazine. Prosperity number.

The prosperity number of *The Railway Magazine* contains articles as follows: Advertising a Railroad; English Railways; Railroads the World's Greatest Benefactors; President McKinley's Inauguration Car; In South America; Samuel Callaway, a biographical sketch; The Foundations of our Growing Prosperity; History and Structure of the Steam Engine; A Year in Florida, and A Tale of Tapestry. The number is illustrated profusely. This is the August number, and, like prosperity, it was a little late in coming.

Modern Locomotives. Illustrations, Specifications and Details of Typical American and European Steam and Electric Locomotives. Published by the *Railroad Gazette*, 32 Park Place, New York. 1897. Price, $7.

This valuable publication has been long in preparation, its appearance having been delayed by the death of D. L. Barnes, who had the work in charge. After the death of Mr. Barnes, Mr. J. C. Whitridge, who assisted in the earlier preparation of the material, completed the undertaking.

Editions of Recent Locomotives appeared in 1883 and 1886, with which our readers are familiar, and the book under review differs from them in that it is not merely a rearrangement of descriptions from the *Railroad Gazette*. The engravings in Modern Locomotives were nearly all specially prepared for the work, and they are more suitable for a book of reference on this account. The task was a hard one, and it has on the whole been well carried out in spite of the fact that practice has been constantly changing during the time occupied in its preparation.

The locomotives are numbered consecutively and those illustrated

in detail are known by figure numbers as well as design numbers, which is a good arrangement. The locomotives are generally shown in half-tone and also in line engravings, the most interesting designs being illustrated in detail. The specifications containing the general dimensions of each engine are given in convenient columns, but these, instead of being all grouped in one place in the book, are interspersed in groups among the illustrations in such a way as to make it a little inconvenient to find the specification for any particular locomotive. This is the only criticism that is offered as to the arrangement. It would have been better to bring the specifications all together, and, as they are numbered consecutively to correspond with the general and detail engravings, the one sought could be more readily found.

Two new and valuable features are the prefatory articles and a table of 137 fast runs made by special and regular trains in various countries. The special articles are very well written, and they cover the following subjects: Recent Improvements in Locomotives, Locomotive Counterbalancing, Locomotive Tests, Locomotive Testing Plants and Experiments with Exhaust Apparatus. These are ably treated, and they constitute a valuable addition to the information given in the other part of the book. Few men have the time to compare drawings and dimensions, even when presented in convenient form, for the purpose of seeking information showing tendencies in design. This work is done admirably in these introductory chapters, and the present state of the art of locomotive building may be seen almost at a glance.

The book contains information concerning 209 American steam locomotives, many of them being shown in detail. Electric locomotives to the number of 24 are shown and five compressed air locomotives are also included. Foreign practice is not presented in complete form, and in view of the great differences in practice here and abroad comparison, except as to general principles, would not be of much value. The ground covered is enough for one book and the selection of locomotives was made so carefully as to cover the ground that is most valuable for comparisons of American practice. No more than this could be expected.

We are glad to have the book in our library. No operating or mechanical railroad officer who pretends to be up to the times will be without it. With the remarkable progress of recent years in locomotive building, it is difficult if not impossible to consult the technical periodicals for purposes of comparison, because of the great volume of such matter. In this book the record of ten years is grouped in such a way as to permit of rapid consultation of the various authorities as their views are shown in their methods of construction. The book ought to be brought before every student of railroad transportation, and especially those who are preparing themselves to enter mechanical railroad work.

The letter-press is excellent, the binding good and the engravings are fair. The half-tone engravings are not uniformly clear and the line engravings would have been improved by the use of the wax process, but the book as a whole is very satisfactory.

We shall be glad to fill orders for "Modern Locomotives" at the price stated above.

Poor's Manual of Railroads, 1897. H. V. & H. W. Poor, New York. $7.50.

This is the thirtieth annual volume of this standard work and it contains the usual tabular summaries showing the results of railroad operation in this country for the past year. The number of miles of railroad operated were 180,891, an increase of 1,737 over the year 1895. The tons of freight moved increased 2.4 per cent., the freight mileage 6 per cent., the number of passengers 1.01 per cent., total gross earnings 3.01 per cent., net earnings 3.23 per cent. and the earnings per ton per mile decreased 0.018 cent. or 2.15 per cent. during the year. The following information is taken from the introduction to the manual :

The share capital corresponding to the mileage completed at the end of 1896 was $5,373,187,819, against $5,182,121,999 in 1895, the increase being $191,065,820, the rate of interest being 3.7 per cent.

The funded debts of all the lines at the close of the year aggregated $5,461,856,598, a sum $179,085,969 less than the aggregate bonded indebtedness reported for 1895 ($5,640,942,567), a decrease of 3.17 per cent., this decrease in bonded debt being the first result of the many reorganizations that have recently been undertaken.

The other forms of indebtedness of the several companies at the close of the year equaled $444,149,969, against $418,505,092 for 1895, an increase of $25,994,877. The total share capital and indebtedness, exclusive of current accounts of all the roads making returns, equaled at the close of the year $11,279,511,386, an increase in the year of $37,974,728 over the total of 1895 ($11,241,569,658), the rate of increase for the year being 0.31 per cent.

The cost per mile of all roads making returns, as measured by the amount of their stocks and bonded indebtedness, equaled $59,732, against $60,188 for 1895.

The gross increase in railroad mileage during the calendar year 1896, represented by the new construction within the twelve months, was 1,996.72 miles. The net increase in mileage during 1896 was 1,688 miles, bringing the total for the whole United States up to 182,600 miles, January 1, 1897. Statements showing for each State the number of miles constructed in the three years, 1894-6, of the total mileage by States and groups of States at various periods are given.

This year further efforts have been made toward greater accuracy in these tabulations by the elimination of the statistics of 178 railroads, consisting chiefly of switching roads, or roads operated in connection with other industries. It was found that the switching roads were merely auxiliary lines, whose tracks might more properly have been included under the head of "Second track, sidings, etc.," whereas the operation of the private lines is in most cases merely an incident in the transaction of the business enterprise, to facilitate which the several lines were built.

The statements of the steam railroads commanding the widest attention necessarily occupy the largest and most important section of the manual. Next in importance is the City and Suburban System of Railways, which, within the past few years, has been practically revolutionized by the substitution of electric traction for the animal traction formerly employed, and which is now undergoing a most extraordinary development. In this department of the manual there has been a slight curtailment this year, due to the omission of statements of electric and other tramways operating in cities with a population of less than 25,000 inhabitants.

Trade Catalogues.

[In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. These are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

The Sargent Company, manufacturers of railroad brakeshoes and steel castings, has issued a handsome pamphlet, illustrating and describing the Diamond "S" Brakeshoe, in which expanded metal is embodied in the casting. The effect of the expanded metal on the wearing of the shoes and the braking power is described, as well as the effect of the wear of the brakeshoe on the wheel surface. The general offices of the company are 675 Old Colony Building, Chicago.

The Brooklyn Rapid Transit Company, controlling the Brooklyn, Queens County & Suburban, the Brooklyn Heights and the Boooklyn City Railroads, has just issued an attractive folder containing a great deal of information about the territory covered by these lines. A large map gives the names of the streets in Brooklyn and shows the locations of the lines and the suburban towns reached by them. It is issued by Mr. H. Milton Kennedy, General Passenger Agent, 168 Montague street, Brooklyn, N. Y., who will be glad to forward copies on receipt of a two cent stamp.

The Q & C Company last issued a series of pamphlets illustrating and describing the railroad specialties manufactured and sold by them. We have received several of these, among which the new Q & C shop saw No. 1, the pressed steel journal box lid, formerly known as the "Drexel" lid, the Priest snow flanger and the Q & C improved inside check valve are illustrated and described.

Axle Light.—The National Electric Car Lighting Company, of New York, has just issued a little book of rules for use in caring for its electric car lighting equipment. The chief feature of the book is its small size, which impresses one with the fact that the care of the equipment does not involve much trouble. It is divided into three parts: A, operation; B, inspection; C, general rule. The different positions of the switches are shown in a small diagram which is carefully explained in the rules. An appendix contains a description of the system of train lighting, furnished by this company. The book is 3½ by 5½ inches in size and is bound in cloth.

WESTERN RAILWAY CLUB. Catalogue of the David L. Barnes Library. Chicago, 1897.

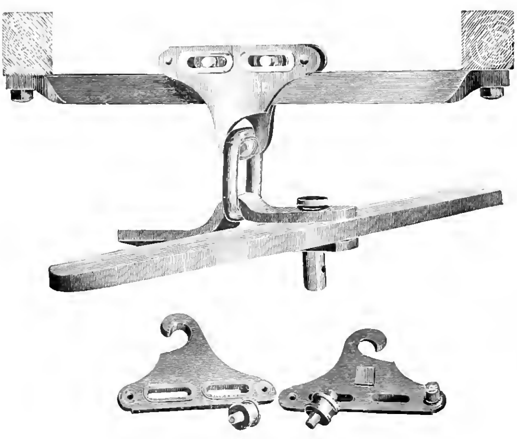
This catalogue was prepared by direction of the Trustees of the David L. Barnes Library of the Western Railway Club which now numbers 824 volumes, constituting the working library which Mr. Barnes bequeathed to the club. The list is published in order to render the library more useful to the members of the club and to enable them to have conveniently at hand a list of the books which may be consulted at the rooms. The list was compiled by Mrs. H. de K. Woods, Librarian.

NEW YORK CENTRAL CAB AND CARRIAGE SERVICE.—The New York Central & Hudson River Railroad has issued a folder giving information about its cab and carriage service put into effect in New York City Oct. 4, 1897. Its purpose is to give information desired by travelers as to the cab service, the districts into which it is divided, and the rates. The vehicles are described and all information necessary for getting the benefit of the new service is given. On the reverse side of the folder is a map of New York, with the districts plainly indicated.

The *Colliery Engineer and Metal Miner* changes its name to *Mines and Minerals* with the November issue. Originally the paper was exclusively a coal mining publication and the name was particularly appropriate. The broadening of the scope of the paper has made the change a desirable one and we wish our contemporary success under the new name even better than that which has been enjoyed under the old.

A New Brake-Lever Carrier.

The accompanying engraving shows the construction of the Durant Noiseless Brake-lever Carrier, which was devised to overcome the scraping and rasping noises of the levers of air-brake systems by doing away with the causes for the grinding. The illustration shows the device as applied to an equalizer lever. The carrier consists of two castings receiving the trunnions of



The Durant Brake-Lever Carrier.

two rollers and riveted together with the rollers in place. The lower edges of the castings are formed into sister hooks which are sufficiently far apart to admit of removing and replacing the hanger links by giving it a quarter turn. The rollers bear upon a bar of ½ by 1½-inch iron. The device is manufactured and sold by the Hampson Flexible Steam Joint Company, of Lakeport, N. H.

The Interstate Commerce Commission and the Safety Appliance Act.

The approach of the limit of time set by the act requiring the application of air-brakes and automatic couplers on cars used in interstate commerce is causing uneasiness among those railroad officers who have conscientiously tried to meet the requirements. Others have assumed that an extension of time would be granted and have acted accordingly. Some of these may be disappointed, as the following statement of the present situation, recently received with other papers relating to the act, indicates:

The Chicago & Alton and other roads, having filed petitions with the Interstate Commerce Commission, asking for extension of time within which their cars, under the act of March 2, 1893, are required to be equipped with automatic couplers and power brakes, the time fixed by the act being Jan. 1, 1898, the commission has made an order fixing the hearing of such petitions for Wednesday, Dec. 1, 1897, at 10 o'clock in the forenoon, at the office of the commission, when it will hear such petitions as are filed on or before Nov. 15, and at which time all persons interested for, or who oppose an extension of time will be heard. Any person may, at the hearing, or at any time prior thereto, file with the commission any affidavit, statement or argument bearing upon the question.

The commission also requires that any road asking for extension shall publish a notice of the fact, and also post such notice in its several stations.

The commission has also ordered that any railroad filing application for extension shall also make, on or before Nov. 20, 1897, a statement, under oath, of the number of freight cars owned, and the number of freight cars which will be equipped with automatic couplers, and the number which will be equipped with power or train brakes by the first day of December, 1897; the number of freight cars which have been equipped with automatic couplers, and the number which have been equipped with power or train brakes each calendar year since the act went into effect, March 2, 1893.

The commission evidently requires this information to be furnished for the purpose of knowing what effort the carriers have made to comply with the provisions of this law, and when. In the same view the railroads are required to state whether any new cars have been purchased or constructed by them since the act went into effect, which were not equipped with the automatic coupler and the power brake.

The object of all this seems to be to ascertain whether the railroads have endeavored in good faith to comply with the provisions of this act. The commission may extend the time as to one railroad and refuse to extend it as to another, and if it should appear, upon investigation, that some particular road had gone on without any serious intention or design of equipping its cars within the time limited by the act, the same reason would not exist for extending the time to that road which would in the case of a road that had done all it could to comply with the law.

Section 8 of the act relieves the employee of responsibility by continuing in the service of any company which has not equipped its cars as the law requires. But if the commission shall extend the time of any particular carrier, it will deprive the employees of the right which would accrue under the act in case of accident occasioned by default of that road until the period of extension granted by the commission shall expire. If not extended the law takes effect on Jan. 1, 1898. The penalty for failure to comply with it is $100 for each violation.

This feature of the law, however, is not so much to be feared by the railroads as the damage suits which may arise in case the time is not extended.

The following is the text of the circular recently issued by the Commission:

In the Matter of the Application of Certain Railroads for an Extension of the Time for Equipping Freight Cars with Automatic Couplers and Train Brakes under the Act Approved March 2, 1893.

WHEREAS the Chicago & Alton Railroad Company and certain other railroad companies have filed petitions asking for an extension of the time within which their cars are required to be equipped with automatic couplers and power or train brakes under sections 2 and 3 of an Act "To promote the safety of employees and travelers upon railroads by compelling common carriers engaged in interstate commerce to equip their cars with automatic couplers and continuous brakes and their locomotives with driving wheel

brakes, and for other purposes," approved March 2, 1893, agreeably to section 7 of said act; and

WHEREAS other petitions of a similar import, asking a similar extension, will probably be filed;

NOW, THEREFORE, IT IS ORDERED:—

1. That all such petitions, which are filed on or before Nov. 15, 1897, shall stand for hearing at the office of the Commission in Washington, D. C., on Wednesday, Dec. 1, 1897, at 10 o'clock in the forenoon, at which time and place all persons interested either for or in opposition to extending the time as prayed for in said petitions will be heard; and at such hearing any person interested may appear either in person or by counsel, and may file any affidavit, statement or argument bearing upon that question.

2. That every petitioner shall file with the Commission on or before Nov. 20 a statement under oath of the following facts: (*a*) the total number of freight cars owned; (*b*) the total number of freight cars which will be equipped with automatic couplers Dec. 1, 1897; (*c*) the total number of freight cars which will be equipped with train or power brakes Dec. 1, 1897; (*d*) the number of freight cars which have been equipped with automatic couplers each calendar year since March 2, 1893; (*e*) the number of freight cars which have been equipped with train or power brakes each calendar year since March 2, 1893; (*f*) what new freight cars have been purchased or constructed since March 2, 1893, which were not equipped with automatic couplers and train or power brakes and when purchased or constructed.

3. Every petitioner shall, on or before Nov. 20 next, give notice of the fact that it has made application for an extension of time beyond Jan. 1, 1898, as aforesaid, by publishing in one newspaper of general circulation in the largest town upon its line, and by posting in its stations at terminal and junction points, a notice in the following form:

SAFETY APPLIANCES.

"Notice is hereby given that the .... Rail...... Company has applied to the Interstate Commerce Commission for an extension of time beyond Jan. 1, 1898, within which they are required to equip their freight cars with automatic couplers and power or train brakes under sections 2 and 3 of an act approved March 2, 1893, relating to the equipment of cars used in interstate commerce with such safety appliances, and that a hearing upon said application will be had at the office of the Commission in Washington, D. C., on Dec. 1, 1897, at 10 o'clock in the forenoon.

"At that hearing all persons interested for or against the granting of the relief prayed for will be heard either in person or by attorney, and they may file with the Commission affidavits, statements or arguments for or in opposition to said petition on or before such date.

"By order of the Commission: "EDW. A. MOSELEY,
"Secretary.'

Each petitioner shall on or before the date of hearing file with the Commission an affidavit stating that said notice has been posted as herein required and giving the name and place of publication of the newspaper in which the same has been published, and shall make such further proof of the giving of said notice as may be subsequently required; and no petition will be heard unless notice has been given in accordance with this order.

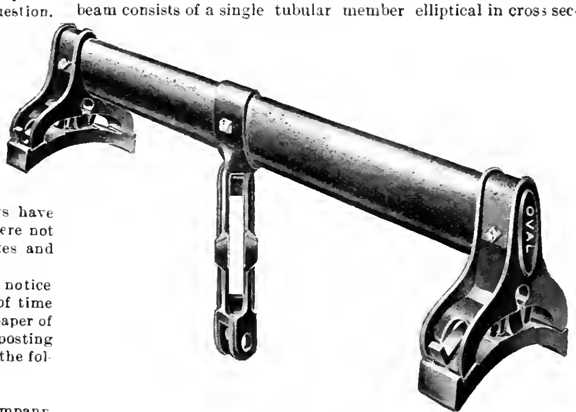
By the Commission: EDW. A. MOSELEY,
Secretary.

The profit to be had from good engineering is shown by *The Electrical World* in a paragraph upon the Ogden power plant, as follows: "There always arises the question of the comparative cost of the electrically distributed water power and the locally generated steam power. Calculated theoretically, the outlook often appears unfavorable for the water power, but the fact must be remembered that steam power in small units is almost invariably developed very wastefully, while the scientifically laid out water-power plant and electrical distribution system is remarkably economical in power. The Ogden plant proposes to supply power over a large area, reaching points, in certain instances, 60 miles or more from the power house. Within this area the cost of slack coal is not more than $2.25 per short ton. When the expense of the heavy dam, the six miles of conduit, and the long transmission line is taken into account, it would seem as though steam power would have the advantage of comparatively lower cost. But this is not the case, owing to the fact that the majority of steam plants are poorly designed, cheaply built, and operated in a careless way that makes the cost per horse-power per annum sufficient to give the electric power a generous margin and a comfortable profit."

The Oval Brake Beam.

With a view of overcoming some of the objectionable features of metallic brake beams and to improve the construction of tubular brake beams, the design shown in the accompanying illustrations has been perfected and placed upon the market by the Oval Brake Beam Company, of Thirty-second and Walnut streets, Philadelphia, Pa.

The arrangement of parts determined upon was intended to make the beam more durable, more effective and better adapted to resist the strains of service. As shown in the engravings, the beam consists of a single tubular member elliptical in cross section, and it differs from all other tubular brake beams in the absence of truss rods. The engravings are sufficiently clear to render a detailed description unnecessary.



The Oval Inside Hung Brake Beam.

Attention should be called to the disposition of the material, which is stated to have been done in such a way as to balance the beam and make it drop away from the wheels when the brake pressure is released. The makers believe that the oval form will render it unlikely to become loaded with snow or dirt, and they also show that there is no place upon the beam where the drippings from refrigerator cars may lodge. The standard section from which the oval brakebeam is made is rolled specially for this purpose, and it is claimed that the thickness as well as the uniform distribution of material give the beam a lateral stiffness superior to other beams.

The Oval Outside Hung Brake Beam.

We are informed that the mechanical and service tests on passenger and freight cars and locomotives, to which this beam has been subjected, show conclusively that the beam will fill all the requirements, although we cannot at present state what the loads and deflections were. We are also informed that the Eastern Railroad Association has passed favorably upon it.

How Can Shop Organization Be Made More Effective?*

L. L. SMITH.

We are living in what has been aptly termed "an age of specialties." The man who is handy at almost anything is rapidly giving place to the man who can do one thing and do it quickly and well.

With the progress of modern civilization and with an ever-increasing keenness of competition in all branches of industry, certain changes of economic policy have developed, chief of which are the centralization of production and the specialization of individual labor.

The case of the locomotive shop, the present organization of which will be described later, may be cited as an instance of the growth of specialized labor in railroad shops. Twenty-five or thirty years ago the erecting shop force was divided into small gangs, a foreman and a gang to each two pits. The machinists' work included both engine and tender repairs, and a workman might be called upon to perform any part of the repair work on an engine or tender. After a while the tender work was separated and given to a special gang which did nothing but tender work; also the scope of operations of the erecting shop gangs was increased from two engines to four and five, and finally, at the present time, each man performs his specialty on each of the 13 engines in the shop. The two principal disadvantages of the early plan of organization were that the cost of supervision was relatively high and a lower rate of individual efficiency was obtained than would have been possible had each workman concentrated his efforts in perfecting himself in some special line.

Of late years, in the experience of most railroads, the small margin between profit and loss, and between dividend and deficit, has magnified the necessity of small economies. Necessity is a hard taskmaster and during the past three or four years of poverty and depression the railroad officer has had the question of reduction of expenses pressed upon him with unusual force. The motive power officer asks himself; "How can expenses in my department be reduced?" His attention is especially directed toward the repair shop, and avenues for possible economies have been explored with greater diligence than ever before.

When business has fallen off the force has been reduced or the working hours shortened, the capacity of the shops being correspondingly cut down. The force is thus reduced to a minimum consistent with the safe and economical maintenance of equipment. Further than this, in the reduction of force, he dare not go. Reduction of wage rate has not, in general, been deemed just or expedient; he must therefore look in other directions for economies. The next question he asks himself is: "How can I increase the efficiency of my shops and reduce the cost of work?"

In order that he may intelligently devise ways and means for the reduction of the cost of work, he must first determine what the work is actually costing under existing conditions. Being armed with this information, he is not obliged to deal and argue entirely in generalities. This information is of great value alike to the Superintendent of Motive Power, the Master Mechanic and the foreman. The importance of knowing what work costs cannot be too strongly emphasized. The piecework principle is the embodiment of this idea, but even the most ardent opponent of the piecework plan cannot consistently object to determine what his work is costing.

The knowledge of the cost of work in various places has led to a certain friendly rivalry between different shops on the same system, each trying to outdo the other; this has resulted in many permanent economies. This condition of rivalry with its attendant good results has been the experience of more than one railroad system.

A few months ago the writer was called upon to reorganize the erecting department of a large locomotive repair shop and place it upon the piecework basis. As a preliminary, various railroad shops were visited for the purpose of studying their organization. The policy of specialization of labor was found to obtain quite largely in both day work and piecework shops and upon plans quite similar.

Previous to taking up the work of reorganization the cost in detail was kept of all the different operations in the erecting department. For this purpose cards were used of the form here shown:

Operation..
....
Charge to..
Material..
Workman...
Time commenced..
Time finished..
No. hours..................................Cost..............................

These cards were filled out during a period of six or eight weeks and at the end of that time several hundred cards had accumulated which covered pretty thoroughly all different operations. The information from these cards was then collected in systematic shape and compiled into a piecework schedule which was of great assistance in subsequent work.

The erecting shop consists of 13 pits, and the force formerly consisted of three gangs, each under a separate foreman. When the new plan was put into effect the force was composed of 21 machinists and 7 helpers; one gang foreman was given the supervision of the 13 pits, another was appointed his assistant, and the third was given a position in one of the gangs. The work of erecting shop repairs was separated into six divisions or special lines and the force divided into six gangs, each gang taking a particular line of work on each of the 13 engines.

The gangs were divided as follows:

Gang.	Machinists.	Helpers.
Valves	3	..
Guides	6	
Driving boxes	5	
Steam pipes	3	
Boiler trimming	3	..
Wheels	1	2
General laborers	..	5
	21	7

The lines of work are divided as follows:

The valve gang has the valve motion work; taking down and putting up steam chests, rockers, links, eccentrics, tumbling shafts, reverse levers, and setting the valves.

The guide gang has the guide, crosshead and piston work; taking down, fitting and putting up cylinders, saddle and frames.

The driving box gang fits up the driving boxes, shoes, wedges, and also repairs and fits up engine trucks.

The steam-pipe gang takes down, fits up, tests and puts in the steam pipe, dry pipe, dome and throttle rigging.

The boiler-trimming gang has the cab and engine trimmings, injectors and pipes, also the clamping of the frame and finishing of the engine.

The wheel gang strips, takes out and puts in driving wheels, and fits up driver brakes, grates and grate rigging.

The general laborers clean the work and distribute it to and from the machine shop and make themselves generally useful.

The determination of proper size of gangs and the requisite distribution of work was a matter of calculation rather than of guess, and was determined on the basis of the normal output of engines per month, the cost of necessary work in detail per engine, and the earnings per month which each man, with reasonable activity, should earn. A trial distribution of work and arrangement of men was laid out, and where it was found, by summing up a line of work, that a gang of a certain size would not have enough work to keep it going, either more work was added or the number of men reduced. For example, if gang A and gang B had each too much work for two, and not enough for three men, a part of the work of gang A would be transferred to gang B, two men would be allotted to gang A and three to gang B.

In shop work in general, the size of a gang has an important bearing upon efficiency. For example, a study of piecework earnings in freight car repair work brings out this fact. If four men are at work on a car their earnings per man will be less than though two of those men, working with the same activity, had the car to themselves, which goes to show that, in general, with gangs of two men per car a more efficient organization is obtained than with gangs of a larger number.

In seeking to extend economies in the shop, the improvement of the efficiency of the individual workman, as well of the betterment of facilities, ought not to be lost sight of. Those who have read Kipling's "Law of the Jungle" have no doubt been impressed by these lines:

"For the strength of the pack is the wolf
And the strength of the wolf is the pack.'

A paraphrase applicable to railroad shop organization might read thus:

For the efficiency of the shop is the workman
And the efficiency of the workman is the shop.

In conclusion, the principles underlying an economical shop organization may be summarized as follows:

First. To determine in detail how much each operation ought to cost.

Second. From this cost to ascertain how much work a man ought to perform to earn a day's wages.

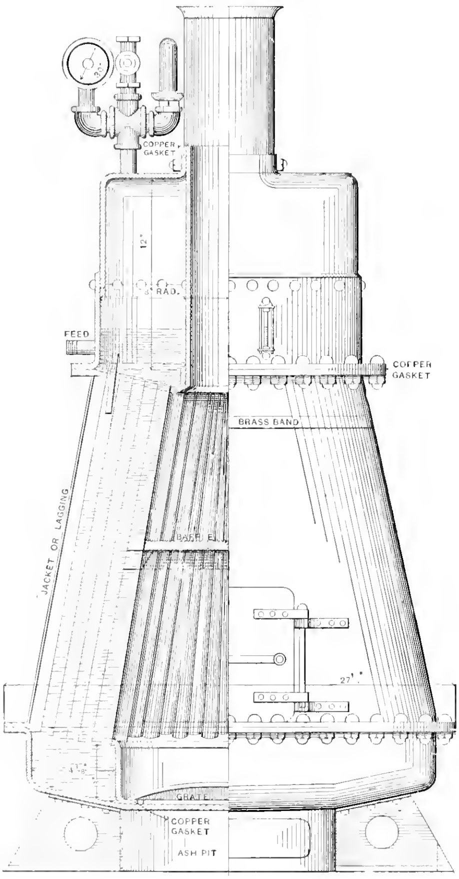
Third. To see that the workman performs this amount of work.

* From a paper read before the Western Railway Club, Sept., 1897.

The Watson Radial Water-Tube Boiler.

The design of water-tube boiler shown in these engravings employs straight tubes, connecting at the upper and lower ends with water spaces, and above the water considerable steam space is provided. The chambers and dome are of steel plate, riveted and bolted together as indicated, and the furnace is surrounded by the water bottom. The last-mentioned member, the tubes, the dome and smokestack constitute the whole of this simple construction, which may be easily repaired.

The tubes are expanded into the upper and lower tube sheets. The outside course of tubes are down comers and a diaphragm separates from the next row, which are steam-forming tubes.

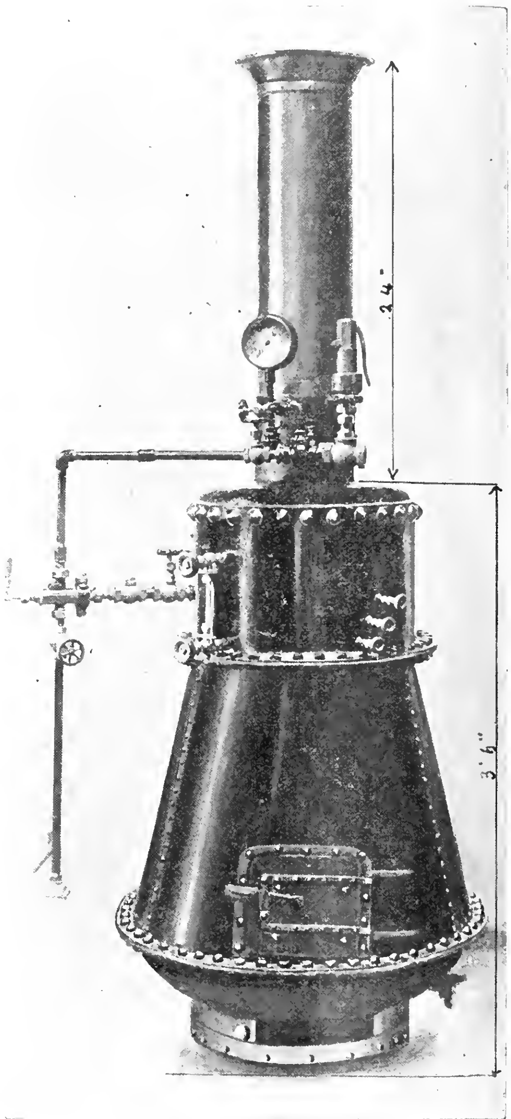


The Watson Radial Water-Tube Boiler.

The furnace has a baffle plate, as shown in the sectional view. The smoketube is attached to an internal flange of the upper tube sheet and it is also secured to the top flange of the dome.

Such a boiler ought to be a rapid steamer, and it is stated that one of them has shown a pressure of 150 pounds per square inch with cold water in 15 minutes after the fire was lighted. The gage showed steam pressure in eight minutes, and in 10 minutes 10 pounds pressure was obtained, after which the blower assisted in bringing up the pressure. This is made possible by the small amount of water in the boiler and the favorable disposition of the heating surface. The circulation is also favorable to this result. The boiler has been severely tested, the firing having been heavy enough to burn anthracite coal at the rate of 60 pounds per square foot of grate per hour by using forced draft. It is stated that such a rate has been kept up for an entire day without showing any bad effect on the boiler. This is certainly a very small boiler for such a performance. Its dimensions are as follows:

Dome: 16 inches diameter by 12 inches high. Steam tubes: number, 58; length, 20 inches; outside diameter, 1 inch. Water

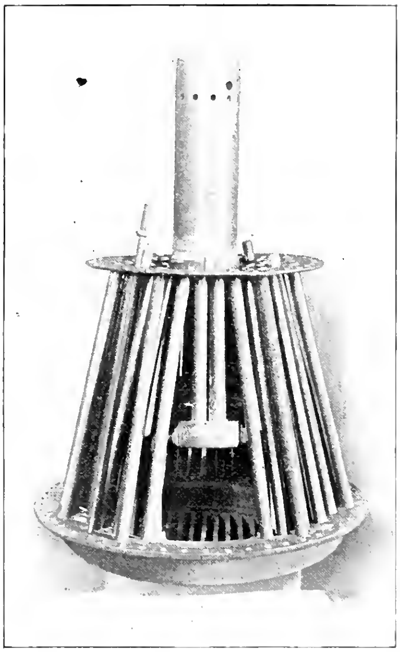


The Watson Radial Water-Tube Boiler.

bottom: diameter, 27½ inches over flanges: depth, 3 inches. Furnace: depth, 2¼ inches, which is too shallow for the best results.

The boiler is very compact, and may be strongly built. It is self-contained, not requiring foundation or casing other than what is furnished with the boiler. It has been passed upon by the Board of Supervising Inspectors of the Steamboat Inspection

Service and was found to be satisfactory. The manufacturers are prepared to furnish boilers built on this plan for sizes up to 500 horse power. One of that capacity would be 10 feet high to the top of the dome and less than nine feet wide at the widest part. It would weigh about eight tons. It is very light in weight, though there are some lighter forms; there are no fire-bricks or heavy parts not directly concerned in the production of



Tube System of the Watson Water-Tube Boiler.

steam. All of the joints are outside of the boiler, where they are accessible. The flanged joints might be expected to give trouble, but it is stated that they do not when they are properly packed, even when subjected to a pressure of 200 pounds per square inch.

The designer and patentee is Mr. Egbert P. Watson, Downing Building, New York.

Graphite Paint.

The importance of coating surfaces of metallic framework and other structures to protect it against the action of moisture and gases is now being recognized more nearly as it should be, and during the past four or five years more attention has been given to this subject than ever before. It never was so important as at present owing to the vastly greater use of metal in structures, and since it has been discovered that steel parts of building frames must be encased in order to withstand heat, the question of what paint to use on these parts which can not be examined without tearing the building down has given engineers and architects no little uneasiness. Bridges over railroad tracks have corroded and required renewal from the effect of the gases of locomotives, and one railroad has gone so far as to encase the steel work of a number of viaducts over its lines in terra cotta in order to effectively dispose of the corrosion. Even when thus encased the steel work is not entirely safe unless it has been protected by the right kind of paint. The city of New York is now carrying out an extensive series of tests for the purpose of ascertaining the relative merits of various kinds of paints for highway bridges with particular reference to their durability, and $7,000 is not considered too much to pay for the information.

There are great differences of opinion with regard to the selection of paints, and for a long time there has been rather a sharp controversy between the advocates of red lead and of iron oxide paints. Several valuable papers have been read before the chief engineering organizations in which the merits of each have been set forth, and one result of the discussions has been to call attention to other paints having the best of claims for attention. Mr. M. P. Wood, in one of his papers before the American Society of Mechanical Engineers, specifies the essential qualities of good paints for metallic structures, and states that they should not only adhere firmly to the surface to be protected and not peel or chip off, but that they should be free from any tendency to undergo chemical changes within themselves. They must be non-corrosive as regards effecting the material covered, and the paint surface must be hard enough to resist frictional contact and yet elastic enough to conform to temperature changes. In addition to these requisites, paint ought to work and cover well. The best paint is that which meets the other requirements and also permits of covering the given surface with the minimum amount of paint. Mr. Wood has freely expressed his views with regard to graphite paint, and from the study he has given the subject his opinion is valuable. The following statements are quoted from one of his papers before the American Society of Mechanical Engineers (see Vol. XVI., p. 700, Trans. A. S. M. E.):

The Detroit Graphite Manufacturing Company, the analysis of whose brand of "L. S. G." amorphous graphite pigment is given in Vol. XV., page 1072, Trans. A. S. M. E., presents some samples of its application to boiler tubes exposed to the combined action of fire and hot water under pressure which will be of interest to the members, and to which attention is called.

The resistance of these brands of paint to the corrosive action of acids or alkalies is very remarkable, as the following severe tests will show: Pieces of iron painted with them have been dipped in muriatic, sulphuric and oxalic acids and then allowed to dry with the acid on them for 19 days without showing a trace of damage to the paint. The longest time which other paints withstood these conditions was 24 hours, and then they were rapidly and entirely destroyed. These paints have been immersed in ammonia and sal soda for 19 days, in coal oil for several weeks, in strong brine for *six years* without showing injury. Pieces of iron have been coated with "L. S. G." and submitted to 24-hour tests in boiling alcohol, boiling beer, boiling brine, boiling sugar and water without the paint showing injury. Red lead paint exposed to boiling alcohol stood 15 minutes, in boiling beer 30 minutes, in boiling brine 25 minutes, in boiling sugar and water 15 minutes. "L. S. G." paints immersed in cold softsoap stood 24 hours without injury, while other paints stood for one hour only. All of the above tests are extremely severe conditions, and even hardly arise in practical use, except under exceptional cases. Smokestacks painted with "Superior" graphite paint have been heated to redness without blistering. Sheet tin coated with these paints can be twisted and bent in all directions without scaling or cracking the paint.

These tests are severe enough to satisfy any one of the merits of graphite paint, but we have another report of equal value, made upon the results of a practical application of superior graphite paint from Mr. John B. Smith, Superintendent of the Union Depot in Detroit, who says:

We have had considerable experience with Superior Graphite paint. The best test that we have had was upon our viaduct. We had that portion of it crossing the Michigan Central Railroad covered with this paint about two years ago, and it shows first rate at the present time. There are engines passing to and fro under this part of the viaduct continusuly the whole 24 hours. The most severe test we have had was at the time of the fire at the Michigan Central flour sheds. At that time the flames played upon our iron work for 2½ hours, and at the expiration of that time the paint did not show the least sign of blistering.

The specifications for the Majestic Building in Detroit and also those for the new Astoria Hotel in New York required the use of this paint. The latter building uses 10,000 tons of structural steel requiring 140 barrels of paint, which is the same brand referred to by Mr. Wood and Mr. Smith.

Mr. Max Toltz, in a paper before the Civil Engineers' Society of St. Paul, advocates the use of graphite paints as follows:

In the past red lead was largely, if not exclusively, used as a paint for iron and steel structures, but within the last ten years it has been to a great extent discarded by progressive engineers and builders. It is true that we to-day have advocates of red lead as the best paint. Still, the fact that these so-called red-lead men now begin to add carbon black or graphite to their paint is a sure sign that they themselves no longer believe red lead alone to be the best pigment.

Fifteen years or more ago iron-oxide men appeared and flooded the country with their various grades and qualities of iron-oxide paint, as being the paint which nature itself had provided for the protection of steel and iron structures against rust and corrosion. From the investigations made, as well as from practical experiments, it appears that the iron-oxide paints are not very desirable, at least for the first coat or two, for iron or steel; but, as a third coat, for the protection of the underlying paints, they may be recommended.

However, the extensive investigation of the graphite paints that can be obtained in the markets to-day shows that, if properly applied, they are far superior to iron-oxide paints for the second or third coat, especially as they withstand the action of moisture and

water much better than the best iron-oxide paint, so far examined Besides, a graphite paint in paste form, well ground and mixed with boiled linseed oil, will not cost very much more per gallon than the cheapest iron-oxide paint in the market.

Rolling Stock in the United States.

According to the statistics of the Interstate Commerce Commission for 1896, advance proofs of which have just been received, the total number of locomotives in service on June 30, 1896, was 35,950, or 251 more than on the same date of the preceding year. Of this number 9,943 were passenger locomotives, 20,351 were freight locomotives, 5,161 were switching locomotives, and 495 were unclassified. The number of cars of all classes in service was 1,297,649, indicating an increase of 27,088 cars during the year ending June 30, 1896. The number of cars assigned to the freight service increased 25,768, being 1,221,887. The statistician's office has no record of the number of cars owned by private companies and individuals that are used by railways in the transportation of freight.

From summaries in the report indicating the density of equipment and its efficiency in the transportation of passengers and freight, it appears that the railways in the United States employ 20 locomotives and 713 cars per 100 miles of line. Referring to the country at large, it is shown that 51,471 passengers were carried and 1,312,381 passenger-miles accomplished per passenger locomotive. It is also shown that 37,634 tons of freight were carried and 4,684,210 ton miles accomplished per freight locomotive. The number of passenger cars per 1,000,000 passengers carried during the year ending June 30, 1896, was 64, and the number of freight cars per 1,000,000 tons of freight carried was 1,595. This average, however, does not include the freight cars owned by outside parties, for the use of which the railways paid nearly $12,000,000. The total of equipment, including in the term locomotives and cars, on June 30, 1896, was 1,333,599. Of this number, 448,854 were fitted with train brakes, and 545,583 with automatic couplers. The increase in equipment during the year was 27,339, and while the increase in the number fitted with train brakes was 86,356 and the increase in the number fitted with automatic couplers was 136,727, the comparison shows that much remains to be done before the total equipment of railways will be furnished with the automatic appliances mentioned.

On June 30, 1896, the number of passenger locomotives fitted with train brakes was 9,816, and the number of freight locomotives was 17,921. The number of passenger locomotives fitted with automatic couplers was 4,503, out of a total of 9,943, and the number of freight locomotives was 3,373, out of a total of 20,351. The number of passenger cars fitted with train brakes on June 30, 1896, was 32,413, and the number fitted with automatic couplers was 31,846, out of a total of 33,003. The number of cars in freight service fitted with train brakes was 379,058, and the number fitted with automatic couplers was 500,233, out of a total of 1,221,887.

Acetyline in Car Lighting.

Although there has been much discussion for and against the use of acetyline for lighting purposes, the German experimenters seem to be forging ahead in their efforts to develop the industry up to a commercial basis. As an example, the tests of the firm, Julius Pintsch, who control the use of Pintsch gas in Germany, and the Prussian railway explosion tests, may be mentioned. The chief engineer of the Pintsch company, H. Gordes, recently read a paper before the Association of German Technical Engineers upon an exhaustive series of tests made with pure acetylene, and its admixture with other gases when confined in the usual gas tanks employed on passenger cars. After showing by official statistics the amount of electric lighting of passenger coaches on the railways of the world, and the subsequent adoption in many cases of Pintsch gas, he gives the results of acetylene tests which are too lengthy to be reproduced here, but may be found in the *Zeitschrift für das Gas und Wassersach* (Vienna, June 25 and July 10, 1897), and the *Journal für Gasbeleuchtung und Wasserversorgung* (July 17 and 24, 1897).

Contrary to assertions which have been made, the union of copper and dry acetylene was not corroborated. "Only under the conditions favoring the formation of copper ammonia oxides on copper oxide in addition to the presence of ammonia does the combination of acetylene and copper take place. Those conditions of combination could not happen very frequently in practice." He also states that tests have shown that acetyline is not more poisonous than coal gas.

Pure acetylene gas decomposes at about 1,436 degrees Fahr., while a mixture of 30 per cent. of acetylene with Pintsch or coal gas is estimated to decompose at about 1,800 degrees Fahr. (or 2,282 degrees Fahr. according to Professor Lewes), making the latter comparatively safer. Mr. Gördes says: "By the use of mixed gases, consisting of 30 per cent. of acetylene and the rest Pintsch gas, any danger to railways is in my opinion avoided, and explosion is prevented from extending from the connecting pipes into the tank." Before the high temperature, a cherry-red, would be reached in case of conflagration the pressure in the tank would probably cause it to leak and the escaping gas would burn without explosion.

A gas receiver filled with 80 per cent. Pintsch gas and 20 per cent. acetylene tested to 16 atmospheres absolute pressure burst, although it had been previously tested to withstand 40 to 50 atmospheres and the temperature rose to 662 degrees Fahr., and as the solder in a soft-soldered tank melts at 392 degrees Fahr.: there would have been a leak in such a receiver before the compressing temperature had attained a dangerous limit. Explosions with mixed non-compressed gas were not so violent as those with compressed gases, and occupy more time—the explosive wave being longer. The decomposition in any case is sudden, accompanied by deposition of carbon.

To determine what effect acetylene mixtures had on illumination and consumption, another series of tests were made, as shown in the accompanying table, which explains itself. Mixtures of air and acetylene are the most dangerous and have not been experimented with, 35 per cent. of air causing decomposition, according to Le Chatelier, at but 896 degrees Fahr. An enormous gain in illuminating power by the addition of acetylene is noticed. Mr. Gordes' remarks are translated as follows:

"I have especially recorded the increase in lighting power for every single burner, because we cannot assume any general rules, as a small burner is the less efficient for a lighter gas than the larger ones, while in the large burners a heavy gas cannot be burned. Photometric tests have been made with special reference to burners which at the present time are in general use by railways for lighting purposes without showing any marked preference. Every burner was put in place so as to give a full flame without regard to consumption or pressure of gas, and without paying any attention as to whether the size of the flame was most favorable as to consumption or illumination.

"It may be possible to manufacture for the several gas mixtures more efficient burners, and the Pintsch people have made inquiries in this regard among the manufacturers of burners. They have not as yet obtained a steady burner to use with pure acetylene. The mixed gas in Pintsch burners does not show any unsteadiness."

It is seen by consulting the table that the admixture of higher percentages of acetylene in Pintsch gas does not give a better result as to improvement of lighting power. If we remember that only the less pure Pintsch gas made at present needs improving, and that the burner No. 40 used in the cars shows, with an admixture of 20 per cent. of acetylene, an improvement in lighting power of three-fold, we can well understand that such an increase ought to be looked upon as a tremendous advance.

Figuring at the present market price of carbide necessary to make 1 cubic meter of acetylene in a compressed state at 50 cents and a cubic meter of Pintsch gas at 10 cents (impure gas), a consumption of 4.92 liters (0.173 cubic foot) per candle power per hour will cost 0.078 cent. Pintsch gas with an admixture of 20 per cent. of acetylene costs per cubic meter (= 1,000 liters = 35.3 cubic foot) at the above prices about 18 cents, and when the mixture is used in burner No. 40 there is consumed but 1.65 liters (0.058 cubic foot) per hour per candle power at a cost of lighting in this case of but 0.048 cent. Mixed gas containing 20 per cent. of acetylene is therefore cheaper than the use of the cheaper grades of Pintsch gases. When mixed in equal volumes it costs about 30 cents per cubic meter.

Burner No. 40 has a candle power 3.4 times greater with the mixed gas over pure Pintsch gas The latter costs in this burner, 0.551 cubic foot being consumed per candle-hour, about 0.0696 cent. When acetylene can be had at 25 cents per cubic meter, this admixture be more profitable.

If a better grade of gas is mixed with acetylene the improvement in lighting power is not so noticeable; however, it at least doubles the candle power of the best Pintsch gas when 20 per cent. of acetylene is added. When one bases the calculation upon the candle power of the mixture, the addition of acetylene does not increase the cost of lighting. There is thus afforded an opportunity to furnish the present equipment of tanks, pipes and burners with an excellent illuminant without alteration.

We will now take up admixtures of acetylene with coal gas. Unmixed coal gas in a small Pintsch gas burner is not measureable photometrically on account of its burning with a blue flame, but with an admixture of 30 per cent. by volume of acetylene a considerable improvement in the candle-power was noted with the various Pintsch burners used. There is further shown in the table that a mixture of 30 per cent. by volume of acetylene with coal gas gave results equal to those obtained with Pintsch gas.

It might be observed that these photometric observations were made by several officers of the Pintsch firm, who checked each other and, therefore, they should be reliable. The mixtures were accurately made with the assistance of a manometer, and as the mixtures were made many times and the averages taken they are presumably correct.

If we take the price of acetylene as 50 cents and the price of coal gas at five cents per cubic meter we have 0.30 cubic meter of acetyline costing 15 cents and 0.70 cubic meter of coal gas costing 3.5 cents, or a total of 18.5 cents per cubic meter of the mixture, or 12 cents per candle-hour (on the basis of four liters per candle-hour); compare this with unmixed Pintsch gas at 49 cents, and with a 20 per cent. acetyline—80 per cent. Pintsch gas mixture at 30 cents,

The mixing of acetylene with Pintsch or coal gas is done as follows: Two gas meters are coupled in the desired manner, and the two kinds of gas led separately to and connected behind the meters, through which it is drawn by a pump, an elastic bag being used to prevent pulsations.

PHOTOMETRIC TESTS OF PURE ACETYLENE AND ITS MIXTURES WITH OTHER GASES.

Composition per cent. volume.	Kind of burner employed.	Number of burner.	Gas pressure. Inches of mercury.	Gas consumed. Cubic feet per hour.	Equivalent Hefner candles.	Gas consumed. Cubic feet per candle power per hour.	Ratio of lighting power of mixed gas to pure Pintsch gas.
Pure Pintsch gas.	Bray	00	1 34	2 59	16.60	0.156	
		000	1 18	1 69	6.89	0.246	
		0000	1 10	1.38	3.26	0 409	
Compressed to 10 atmospheres.	Pintsch 2 hole	15	0.82	0.67	1.60	0 116	
		30	0.55	0 76	2 9.	0.258	
		40	0.59	1.16	6.70	0.173	
		60	0.98	2.12	13 40	0.155	
90% Pintsch gas	Bray	00	1.34	2 58	34 7	0.073	2 09
		000	1 18	1.70	15.30	0.112	2.22
		000	1.10	1 27	7 70	0.164	2.36
10% acetylene	Pintsch 2-hole	15	0.82	0.62	3 60	0 171	2.25
		20	0 51	0.74	6 70	..110	2.27
		40	0.59	1.16	12.60	0 091	1.88
		60	0 98	2.19	26.60	0.082	1.98
80% Pintsch gas	Bray	00	1.65	2 89	56.20	0 051	3.38
		000	1.38	1 91	28.20	0.067	4 92
		0000	1.38	1.53	16 00	0.095	4.90
20% acetylene	Pintsch 2-hole	15	0.94	0.74	7.25	0.101	1.53
		30	0 59	0.77	10.50	0.073	3 57
		40	0.62	1.18	20.20	0.058	3.01
		60	1 30	2.58	45.20	0.057	3.37
70% Pintsch gas	Bray	00	2.16	3.25	59.90	0.054	3 60
		000	1.73	2 12	31.56	0.061	5.00
		0000	1.57	1.19	19.30	0.077	5.92
30% acetylene	Pintsch 2 hole	15	0.94	0 67	8.52	0.078	5.32
		30	0.63	0.77	11.60	0.066	3 91
		40	0.59	1.18	19 40	0 060	2.89
		60	1 30	2.45	42.50	0.057	3.17
60% Pintsch gas	Bray	00	2 16	2.95	66.16	0 044	3 98
		000	1.73	2.05	40.25	0.041	5.26
		0000	1 57	1.59	24.50	0.061	7.51
40% acetylene	Pintsch 2-hole	15	0 94	0 67	10 27	0.065	6.41
		30	0 63	0.76	13 50	0.055	4.59
		40	0.59	1.16	21 90	0.052	3.26
		60	1.22	2 11	47.50	0.050	3.54
50% Pintsch gas	Bray	00	2 16	3.17	68.55	0.046	4.12
		000	1.77	2.01	40.25	0 049	5.84
		0000	1.57	1.50	28.20	0.053	8.65
50% acetylene	Pintsch 2-hole	15	0 98	0 71	10.80	0.066	6.75
		30	0.63	0.81	13 80	0.058	4 69
		40	0.63	1.23	24.10	0.051	3.59
		60	1 22	2.24	49.50	0.044	3.69
Pure acetylene	Bray	00	3.34	3.63	167.00	0.022	10.06
		000	3 34	2 58	126 00	0 021	18.28
		0000	3.34	2.01	88.50	0.023	27.14
	Pintsch 2-hole	15	1.14	0.67	23 8	0.027	11 87
		30	0.71	0 76	26.00	0 029	8.81
		40	.....	.....	.....	.....	.....
		60	.....	.....	.....	.....	.....
70% coal gas, 30% acetylene	Pintsch 2-hole	15	1.97	0.93 0.95	2.71 3.40	0.280 0.314	
		30	1 18 1.38	1.14 1.28	5.82 5.87	0.195 0.262	
		40	1.18	1.62 1.63	10.83 13.00	0.124 0.151	
		60	0.98	2.08 2.19	19.50 21.50	0.096 0.112	
		X	0.17	1.11 1.27	11.80	0 094 0.107	

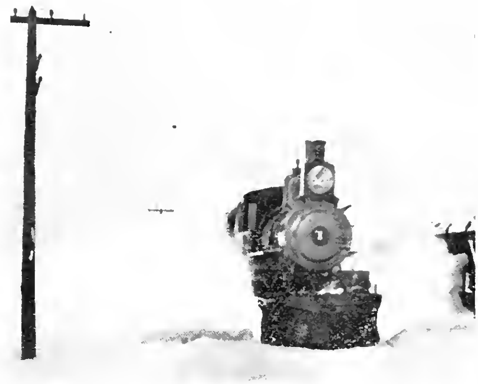
Enriching coal gas for city lighting purposes is not to be recommended, because even at cheapest carbide prices it never will be as low in cost as the Welsbach incandescent lamp. Tests made by heating the supply pipes, carrying acetylene mixtures, to a white heat did not cause explosion, so that local conflagration would not necessarily explode the whole system of piping and reservoirs.

An Excellent Record.

The annual report of the New York Central Railroad Company shows that during last year not a single passenger carried on the lines of that road was killed. The passenger traffic of the New York Central is enormous, for the road carried during the last year 23,166,483 passengers, and of that great number not one was killed and only 15 were injured. The entire number of lives lost along the lines of the New York Central Railroad during the past year numbered but 241, which include employees of the road and others not passengers.

The Priest Flanger.

The Priest flanger in its earlier form is well known, and recently it has been improved by making the knives of a single piece instead of four pieces. The knives are raised and lowered by compressed air, the operation being under the control of the engineer from the cab. The apparatus, except the knives, is very strong and is not likely to break, while the knives will readily break when they come into contact with guard rails or other obstructions. The cut made by the flanger is 12 inches wide by 2



The Priest Flanger.

inches deep inside of each rail, and 12 inches wide by ½-inch deep outside of each rail. The knives are placed behind the pilot and the snow is thrown out as if from a plow. The knives are strong enough to cut through ice or sand, but they readily break upon meeting with any solid resistance. They are placed 1 inch above the top of the rail, which does not interfere with the use of torpedoes. The device is now manufactured and sold by the Q & C Company, of Chicago.

European Electric Light Plants.

In contrasting, in *Cassier's Magazine*, the nondescript character of the larger number of American electric light stations with the substantial, well-laid out installations of Europe, and especially Germany, J. E. Woodbridge says:

"European cities are already of established size, or are growing at a slow rate which can be definitely foretold. The proverbial slowness of the European—from an American standpoint—in establishing new enterprises prevents the construction of lighting plants until the demand to be supplied is known definitely.

"There is also a greater proportion of municipal lighting systems in Germany than in America, and in all these plants, of course, the tendency for the best, as opposed to the cheapest, is greater than under private ownership. Then, those municipalities now owning their own plants have been so stringent in their franchise limitations as to prevent the establishment of any wildcat or speculatively inclined companies, or any, in fact, but those with the most substantial backing and serious intentions.

"The franchise of the Berlin Electric Works Company is a good example. The company is required to pay 10 per cent. of its gross receipts as rental for the use of streets for its conduits; also one-quarter of its net profit over and above 6 per cent. The rates allowed for street lighting are very low, as compared with American

standards, and its maximum allowable rates for private lighting are specified. The company is required to keep on deposit with the city a renewal fund in bonds equal to one-fifth of its invested capital: also a sum of about £10 000 as surety for the provisions of the franchise. Strict rules are also made regarding the tearing up of streets.

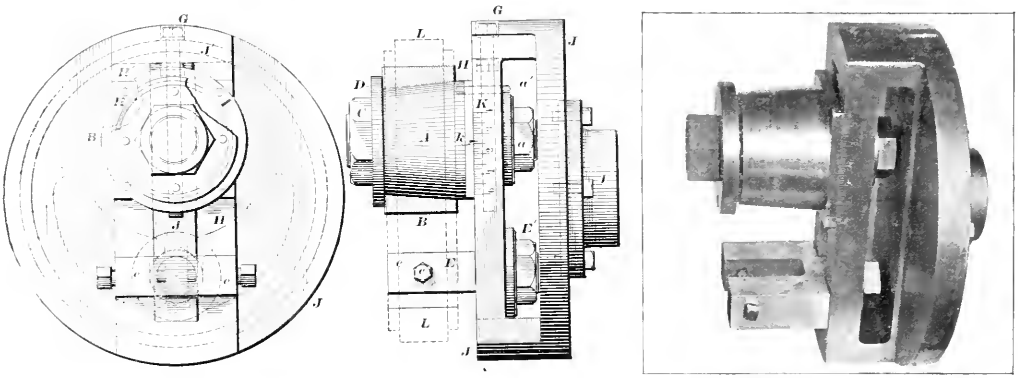
"The difference in the nature of investors in America and Europe is also a prominent factor. While the investment in the United States is generally speculative, calling for quick and large returns, the demand in Europe is for a safe investment, which shall pay a small interest continuously for many years. The result is that, before ground is broken for a European plant, the whole system is laid out with due allowances for everything that can be foreseen in the next quarter century. The best engineering talent available is employed, and all the possible alternatives in plans and details are thoroughly discussed. First cost is not considered if running expenses or depreciation can be reduced in any way. Any increase in capitalization that will effect a saving sufficient to pay 5 per cent. or even less on that increase is immediately undertaken."

A Lathe Chuck for Turning Eccentrics.

A convenient and satisfactory chuck for turning eccentrics in a lathe has been in use for some time at the Schenectady Locomotive Works, and through the courtesy of Mr. James R. Howgate, designer and patentee, we show three views of it in the accompanying illustrations. The arrangement provides for adjusting the eccentricity of the support to provide for different throws. It is used by the Schenectady Locomotive Works for turning locomotive eccentrics, but is adapted equally well for those used on other types of engines or on pumps.

The face-plate *I* is of the usual form, and is screwed on to the lathe spindle in the usual way. To this face-plate a frame *J* is bolted, its outer face being slotted to receive the shank of the taper-pin *A*. A screw *G* extends through one end of the frame and through the shank of the taper-pin. By means of this screw the taper-pin is adjusted in either direction relative to the axis of the lathe spindle, so as to take in eccentrics of different throws; the exact throw is determined by the scale *K*.

A split bushing surrounds the taper-pin, and is made to expand by means of the nut *C* and washer *D* in the bore of the eccentric, which is shown in dotted lines. The set-screws in the lug *E*, whose shank also slides in the slot of the frame *J*, hold the arm of the eccentric, thereby securing a firm hold of the eccentric at one point, while the bushing *B* holds it very firmly at another point. The washer *D* is provided with a series of holes to receive the dead center of the lathe when this is found necessary. By these means the chuck is firmly supported and the work is kept from chattering.



Chuck for Turning Eccentrics.

The South Union Station, Boston.

A general description of the new Southern Union Station in Boston was published in the February issue of the current volume of this journal, and some of the details of a contract recently let for the power plant which is to be installed there will be found interesting. The complete engineering equipment was let in a single contract, including the following features of the plant: The switch and signal work, the power-house plant with equipment for arc and incandescent electric lighting; elevators for passengers, freight and baggage; the heating and ventilating apparatus; refrigerating plant for the cars and the restaurant; piping system for testing air-brakes; fire protection; drainage provisions; frost protection for roof conductors, and steam and hot-water supply for the headhouse.

The switch and signal plant covers the installation of the complete apparatus on the Westinghouse Electro-Pneumatic Interlocking System for handling all of the trains of four railroads to and from the train shed of this terminal, and the handling of the suburban trains through the suburban loop, the tracks of which are so depressed as to handle this traffic through the basement or subway extending under the train shed and headhouse. The air compressors for the switch work will be located in the power-house, as also the electric apparatus for the signal and interlocking plant.

The power-house equipment will consist of 10 boilers fitted with economizers and mechanical draft and about 1,600 horse-power of Westinghouse compound engines direct connected to Westinghouse multipolar generators. The plant will be operated condensing, using salt condensing water from Fort Point Channel, about 100 feet distant, except when the steam is required for heating. A large switchboard carrying a dozen or more circuits for the various miscellaneous uses of electric current will be provided and the entire installation will be of the most complete character and especially adapted to the requirements of the miscellaneous service of a railroad terminal property. A traveling crane will span the engine-room.

The electric arc and incandescent lighting is laid out with especial reference to the character of the service, leading to the employment of a somewhat larger number of distributing centers than is customary in isolated plants, with very complete methods of switching, in order to meet the demands of the lighting and motor circuits, also to aid in economizing power. To the usual wiring conduits extra ones are added for miscellaneous wiring for other purposes and also for telephone service within the property.

Elevators and lifts for passenger, freight and baggage service comprise 19 electric elevators, several of which are for passengers, distributed in the headhouse; two for handling the supplies for restaurants and miscellaneous purposes, while the remainder are special elevators for handling the baggage and express trucks from the train shed to the subway and from the first floor baggage-room to the baggage basements.

The heating and ventilating plant covers the entire heating and

ventilating apparatus for the headhouse and side wings, which together form a building extending around three sides of the train shed and having a total length of about 1,800 feet. The system is a combination of the direct and indirect method, with hot blast furnished by fans driven by electric motors, while the ventilation is assisted by exhaust fans also driven by electric motors.

A 20-ton-ice making plant on the plate system is conveniently situated between the power-house and one of the wings of the terminal building. In connection with this is the refrigerating plant for the restaurant, kitchen and storage boxes, and in place of ice water coolers provision is made in this refrigerating plant for cooling drinking water to be supplied to the taps in the head-house.

The car heating equipment for the train shed, storage and express tracks covers about 40 acres of track space and is arranged to heat cars in any location in which they may be left by locomotives. The air piping for testing air-brakes, is complex covering, 28 train shed tracks and leading to many of the yard tracks.

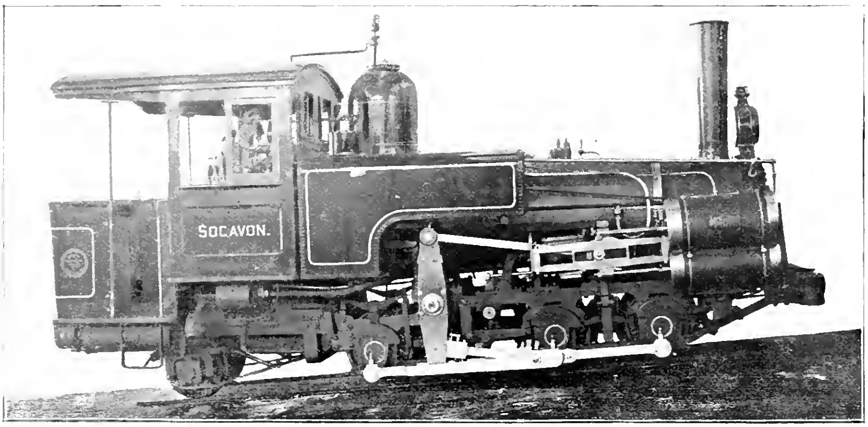
Fire protection is provided by a complete system of high-service mains about the headhouse and wings. Interesting work will be done in disposing of the drainage from the buildings and subways. Many of the latter will be from 10 to 15 feet below tide water, necessitating extensive water proofing. A sump is provided into which the water of seepage and from storms will run, to be automatically pumped out by means of pumps driven by electric motors. Additional pumps for emergencies will be put in, and the necessity for their use will be indicated by automatic alarm when the level of the water in the sump reaches the danger point. There are 14 acres of roofs over the structures and therefore the freezing of conductors in winter would cause great inconvenience. These will be protected in a way to insure keeping them open.

This extensive combination of equipment has been let in a single contract to Messrs. Westinghouse, Church, Kerr & Company, engineers, and the advantage of handling the work in this way will be apparent. An instance of the appropriateness of this feature is seen in connection with the air-brake testing plant and that for the operation of the signals. The pneumatic power would naturally come from the same source, and if the two parts of the work are executed under one contract much expense and confusion may be avoided. This applies equally well in regard to the steam-heating, the hot-water systems and power plant. It is a unique method of handling work of the kind, but there is much to recommend it. The contract was awarded to this company in preference to all others, from the fact that it was able to supply all parts of the equipment, which, it was believed, no other single concern could do: and there is no question of the ability of the company to fulfill its contract. As a whole, the Boston Southern Terminal was designed by Mr. George B. Francis, C. E., Resident Engineer, and the Chief Engineers of the New York, New Haven & Hartford, Boston & Albany, New York & New England and Old Colony railroads, while the President, Mr. Charles P. Clark, and the Board of Trustees have given their special attention and supervision not only to the general features but to many of the details.

Combination Rack and Adhesion Locomotive—The Baldwin Locomotive Works.

The Baldwin Locomotive Works have produced a number of designs of mountain locomotives for use where adhesion could be employed for a part of the line and a rack and pinion for the steep grades. The design shown herewith is novel in that this locomotive is a combined adhesion and rack engine, the change being made from one to the other from the cab. The design is covered by patents issued to Mr. S. M. Vauclain, and the engine "Socavon," from which the photograph was taken, was built by the Baldwin people for the Cia Minera de Penoles, at Mapimi, Mexico.

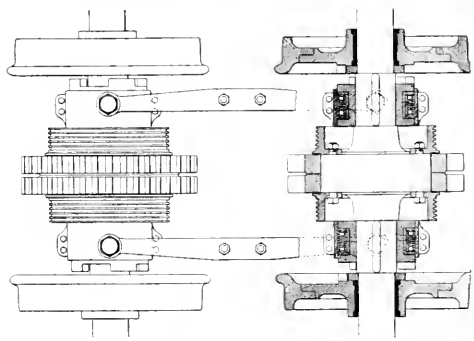
In this design rack pinions are placed upon all three driving axles. The rear coupled axle is fitted only with carrying wheels in addition to the rack pinion, while the two forward coupled axles are fitted with wheels which are merely carrying wheels



Combined Rack and Adhesion Locomotive. By The Baldwin Locomotive Works.

when the locomotive is acting upon the rack portion of the line, but by shifting the clutch they become adhesion wheels when the locomotive is on the adhesion portion of the line.

The engine has cranks outside of the frames, and the rack pinions are permanently secured to the axles and turn with them

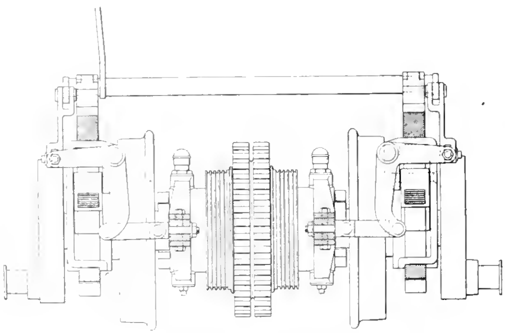


Sectional View Showing Clutches.

at all times. The driving or adhesion wheels are loosely mounted on the axles, and when the rack-wheels are driving the engine they merely carry the weight as supporting wheels, and in order to use them as adhesion wheels the clutches shown in the drawings are operated by means of a lever in the cab, and the carrying wheels are then made to revolve with the axles. The clutches

are positive in the sense of being formed with interlocking arms, yet they are so made that they may be thrown into gear with the engine in motion, when they will automatically lock in position.

The clutch is a modification of the ordinary jaw clutch. On the inner end of the hub of each wheel are projections separated by suitable spaces which form the fixed jaw of the clutch, while on the axle is a sliding section having projections which may be moved into the spaces between the projections of the fixed jaw. This sliding section is splined to the axle and turns with it. There is a sliding section or jaw for each adhesion wheel. The connections between the clutch levers and the sliding jaws are made in such a way as to compress the small spiral springs shown in the sectional view until the projections of the clutches match. This



Vertical Section Through Frames.

is the provision which permits of throwing the clutches into gear while the engine is in motion. The corrugated drums at each side of the rack pinions are for the application of brakes.

The general dimensions of the engine are as follows:

Gage	2 ft. 6 in.
Cylinders	9½ and 15 × 22 in.
Drawing wheels	25¾ in.
Rack wheels	22.468 in.
Driving-wheel base	3 ft. 2$\frac{7}{16}$ in.
Weight, total	About 55,000 lbs.
" on drivers	About 45,400 lbs.
Boiler, diameter	36 in.
Number of tubes	106
Diameter of tubes	1⅙ in.
Firebox length	31⅞ in.
" width	37¼ in.
Tank capacity	400 gals.

We are informed by the builders that the reports which have been received by them as to the performance of this engine are most satisfactory.

Excursion of the Western Society of Engineers.

Early in October this organization enjoyed an excursion to Niagara and to various manufacturing establishments in the East, which was very successful. The party inspected the new steel arch bridge at Niagara at the occasion of its formal opening and visited a number of points of interest to engineers in that vicinity. South Bethlehem was then visited and the process of forging armor plate was seen. The Saylor Portland Cement Mill, the works of the Alpha Portland Cement Company, at Whitaker, N. J., the works of the Ingersoll-Sergeant Drill Company, at Easton, Pa., were visited. At Easton the party enjoyed a dinner at Paxinosa Inn as the guests of the Ingersoll-Sergeant Drill Company, and speeches were made by a number of prominent engineers. After enjoying a brief stay in New York City the party returned West.

The St. Louis Railway Club.

At the meeting of the St. Louis Railway Club, which was held Oct. 8, a paper, entitled "Care of Passenger Cars at Terminals," was read by Mr. J. A. Gohen, and was discussed. Mr. John S. Thurman read a paper, "Advancement of American Railways and What We May Expect in the Future." An adjourned meeting of the Club was held in the evening in the Music Hall of the St. Louis Exposition, which was addressed by President W. G. Besler. The attendance was large and the occasion was an enjoyable one.

A Long Run on the Union Pacific.

During a recent trip taken by the Receiver of the Union Pacific Railway in company with several other persons a remarkable run is reported on the lines of that road. The long run was from Evanston, Wyo., to Omaha, Neb., a distance of 955.2 miles, which was covered, stops included, in 23 hours and 55 minutes, which was at an average speed of 39 93 miles per hour from start to finish. The train consisted of one baggage and two officers' cars, the weight of the train, including the engine, being 491,608 pounds. The engine and tender weighed 226,833 pounds. This work was all done with one engine and one crew. Some remarkably fast time was made, because there were 28 stops, the two longest in duration being 35 and 23 minutes, and several stops occupied 15 minutes each. Figuring roughly, the train must have lost over 3½ hours at stations, and the speed while in motion was high to give the high average. The run from North Platte to Omaha, 290.9 miles, was made in 5 hours and 37 minutes, or at an average rate of 51.8 miles per hour, with eight intermediate stops and a loss of about 40 minutes at stations.

This run is remarkable for the fast time, considering the great amount of time lost at stations, and it serves to call attention in a forcible way to the large proportion of time which must be made up on this account.

The rapidity with which high-speed ships approach each other is shown by Lieutenant James H. Scott in a recent number of *Cassier's Magazine*, in which he says: "Two steam vessels, each having a speed of 21 knots an hour, approach each other at night, end on, proceeding in opposite directions. These vessels complying fully with the law, have the masthead lights visible at a distance of five miles and the side lights visible at a distance of two miles. The night is dark, the atmosphere clear, and the men on lookout pick up the lights the instant they become visible. When the vessels are, say, five miles apart, the lookouts will report the masthead light of the approaching vessel to the officer on the bridge, who is able to see it immediately. He will, however, be unable to tell the other vessel's direction until her sidelights are visible. These he will see when the vessels are about two miles apart, and are approaching the point of collision at the rate of 42 miles an hour. There are available two minutes and 28 seconds for the ships' officers to see the lights, to make up their minds how they can best avert a collision, to give the order to port the helm, for the man at the wheel to obey the order, for the vessel to obey her helm, and for the ships to go clear. Does anyone say that the time is sufficient for all these agents to perform their several functions in ample time to avert a collision?"

In discussing the effect of American competition in the iron trade of Great Britain, the *Mechanical World* says: "The latest move is to be found in keen rivalry from the United States in regard to large cast iron pipes for gas mains. A case in point has just occurred at Glasgow, where the Corporation recently invited tenders for the supply of gas mains of various diameters. When the estimates were opened last week it was discovered, to the surprise of many, that a well-known firm in Philadelphia offered to deliver in Glasgow, the firm paying the cost of freight across the Atlantic, cast-iron pipes of the largest diameter required at a price which works out at £1 per ton less than the lowest tender sent in by a British firm."

EQUIPMENT AND MANUFACTURING NOTES.

Orders have been received by the Baldwin Locomotive Works as follows: Two 10-wheel freight engines for the Detroit & Lima Northern, 10 10 wheel engines for the Omaha, Kansas City & Eastern, and four freight engines for the Rio Grande Western.

H. K. Porter & Company, of Philadelphia, Pa., is building one saddle tank engine, with cylinders 10 by 16 inches, for the Port Townsend Southern Railroad. The engine is to burn lignite coal and is to weigh 41,000 pounds in working order, with 28,000 pounds on the drivers. Paige wheels will be used on the engine trucks, Ajax metal for the bearings, Nathan lubricators and Monitor injectors, Richardson valves and Adams & Westlake headlight.

The Cooke Locomotive and Machine Company is building three 10-wheel 20 by 26-inch locomotives for the Astoria & Columbia River Railroad.

The Pittsburgh & Lake Erie has ordered 10 heavy freight engines from the Pittsburgh Locomotive Works.

The Pennsylvania is building 10 class P, 12 class L and 23 simple mogul engines at the Altoona shops.

The Schenectady Locomotive Works will build 15 instead of 10 10-wheel freight engines for the Chicago & Northwestern, the order having been increased. Orders have also been received for three locomotives for the Ogdensburg & Lake Champlain and for one eight-wheel locomotive for the Astoria & Columbia River.

The Brooks Locomotive Works have taken the following orders: Twenty 10-wheel freight engines for the Lake Shore & Michigan Southern, with 17 by 24-inch cylinders; three 6 wheel saddle tank locomotives for the Siewa Railway of Japan; four 6-wheel coupled side tank engines for the Seol-Chemulpo Railroad of Corea, and 25 locomotives of 5 foot gauge for the Finland State Railroad.

After an inspection trip of 3,200 miles with the Directors of the Pennsylvania Railroad, President Thomson stated that the trip had been satisfactory in every way, and that notwithstanding the enforced economies of the past year the roads were found to be in excellent condition to meet the demands of the increasing traffic due to the revival of business throughout the country; that the long-looked-for prosperity was undoubtedly a reality; that everywhere along the line evidence of a return to business activity was apparent; that the crops were good, and that general business in the large cities seemed to be in a most healthy state.

The Baltimore & Ohio Railroad is building 10 express cars for the use of the U. S. Express Company on the B. & O. lines. These cars are to be 60 feet in length, of extra strength, and so arranged that they can be used for the transportation of fine horses. They will be fitted up with removable stalls, and when not used for horses will be placed in regular service.

The suburban cars of the Illinois Central Railroad in Chicago, which were formerly yellow, have all been painted a dark color, and they have been equipped with Pintsch gas. This work has been done in small installments.

The Player truck has just been furnished by Messrs. Shickle, Harrison & Howard for 100 cars for the Atchison, Topeka & Santa Fe, and for 100 cars for the Kansas City, Pittsburgh & Gulf Railway.

The Baltimore & Ohio Southwestern Railway will lay five thousand tons of steel rail this fall.

On page 345 of our October issue we printed an illustrated description of a large cast steel gear wheel made by The Sargent Company, and have since learned that the teeth of this gear and its pinion were not touched after leaving the sand except to trim the edges. The pinion weighed 9,000 pounds, and the gears are running very successfully at the works of the Great Western Tin-Plate Company, at Joliet, Ill.

The heat insulation of the steam pipes at the new Concord shops of the Boston & Maine will be furnished by the Keasbey & Mattison Company, of Ambler, Pa. This is an extensive piping system, reaching more than 700 feet from the boiler house in one direction and over 800 feet in the opposite direction. More will be said upon this work in a future issue.

The water of condensation from the steam separators in the power-house of the Boston & Maine shops at Concord, N. H., is returned to the boilers by a Bundy return steam trap, furnished by the A. A. Griffing Iron Company, of New York.

The Schoen Manufacturing Company has received an order to build 50 steel cars of 100,000 pounds capacity for the Pittsburg & Lake Erie Railroad.

The Grand Trunk has placed an order with the Michigan-Peninsular Car Company for 500 box cars of 60,000 pounds capacity. They will be equipped with M. C. B. couplers and Westinghouse air-brakes. The road will also build 500 additional box cars of the same capacity and from the same specifications at its own shops.

The Chicago, Milwaukee & St. Paul has ordered eight vestibule coaches from the Barney & Smith Car Company. This road is building 1,000 box cars at the West Milwaukee shops.

The Monarch brakebeam will be applied to the postal and buffet cars building at Pullman for the Illinois Central.

The Wabash has placed an order for 250 standard 60,000-pound box cars with the Missouri Car and Foundry Company, and for 250 with the St. Charles Car Company.

The Buffalo, Rochester & Pittsburg has ordered 100 freight cars of 80,000 pounds capacity from the Jackson & Woodin Manufacturing Company, of Berwick, Pa. The same company has ordered 100 additional freight cars from the Buffalo Car Company.

Messrs. Wm. Sellers & Company, Philadelphia, have received an order for a 75-ton traveling crane with a 20-ton auxiliary hoist, a 20-ton travelling crane with a 5-ton auxiliary hoist and a 10-ton traveling crane, from the Bethlehem Iron Company.

The Baldwin Locomotive Works has completed a steam motor car on the Vauclain compound principle for use on the Cincinnati, Hamilton & Dayton.

Armour & Company has ordered 200 more refrigerator cars from the United States Car Company to be built at Hegewisch, Ill.

The Pennsylvania is building 11 coaches at Altoona. These will have Pullman vestibules, Janney-Buhoup three-stem couplers, Gordon-Mitchell lamps for burning compressed gas, Edwards window fixtures, Wheeler seats and Forsyth roller curtains. The trucks will be the Pennsylvania latest standard four-wheel pattern with 4¼ by 8-inch journals and will be equipped with two inside-hung National hollow brakebeams.

For the first time in years the shops of the Cumberland Valley Railroad, at Chambersburg, Pa., have gone on 10 hours' time. The freight business on the road is the largest in 15 years, and the officials fear their motive power will not be sufficient to carry the heavy volume if the rush continues.

The Ingersoll-Sergeant Drill Company has received orders for two 20-inch duplex air compressors for the Great Northern road. They will be used at the Cascade tunnel on that line. This concern is also building a duplex cross-compound compressor for the shops of the Chicago, St. Paul, Minneapolis & Omaha road. The latter will be of the same size as the three compressors built by the same company for the Santa Fe road.

The Schoen Pressed Steel Company, of Pittsburg, has bought the rolling mill plant of the Oliver Iron and Steel Company, at Woods Run, Pa.

Mr. R. H. Soule, of the Baldwin Locomotive Works, sailed for England in the *St. Paul*, Oct. 6. Mr. Soule will spend about two weeks in London and go from there to the Continent on business for the Baldwin Locomotive Works.

The Rem-Lap Manufacturing Company, St. Paul, Minn., is introducing a disappearing screen for the windows of railroad cars. The screen is of fine mesh wire cloth carried in a metal frame and is attached to the lower bar of the window sash. The frame rises with the window, and when the window is closed the screen disappears in a recess below it. The window may be opened or closed without interfering with the screen, and when the window is raised the opening is protected against the admission of cinders. These manufacturers also make deck screens and metal frame fenders which are better than wooden ones for the reason that they are not subject to swelling and shrinking with changes in the weather.

The Pennsylania Railroad Company has purchased 40,000 tons of steel rails at $19 per ton for 30 foot rails and $20 for 60-foot rails. The contracts were awarded to the Pennsylvania Steel Company, the Cambria Iron Company and the Carnegie Steel Company, and all the rails are to be delivered before Jan. 1, 1898. The new rails are to be used for double-tracking the Atlantic City Division of the West Jersey & Seashore Railroad, and replacing old and lighter rails on other parts of the Pennsylvania Eastern lines.

Offices have been opened at 120 and 122 Liberty street, New York. by the Chicago Pneumatic Tool Company.

The Whiting Foundry Equipment Company, of Harvey, Ill., has recently taken a contract for a 6,000-pound capacity traveling crane for the Elwood Tin Plate Company of Elwood City, Pa. The crane will be operated by a compressed air motor and will have two pneumatic hoists.

On Oct. 9 the National Electric Car Lighting Company, of New York, shipped 50 installations of electric light equipment, generated from the car axle, to Topeka, Kan., for the equipment of 50 cars of the Atchison, Topeka & Santa Fe Railway. The cars that will have this electric light are :

14 vestibule cars.
5 vestibule coaches.
4 composite cars.
9 non-vestibule, smoking-room chair cars.
8 vestibule smoking-room chair cars.
10 dining cars.

This will be the first equipment of electric light generated from the car axle on a large scale. The cars will run on all main line

trains of the Atchison, Topeka & Santa Fe Railway to Kansas City, Denver, El Paso, Los Angeles and Galveston.

The Ashton Valve Company has sent us an attractive and serviceable souvenir in the form of a pocket coin pouch.

We have received photographs with the leading dimensions of the following locomotives recently built by the Brooks Locomotive Works for foreign service:

15 by 22 inch, 6-coupled side tank locomotive for the Koya Railway of Japan.
21 by 24 inch, 10 wheel passenger, Mexico, Cuernavaca & Pacific Railway.
13 by 18 inch, 4-wheel saddle tank, Transvaal, South Africa.
14 by 20-inch, 4-coupled double-ender, Kiwa Railway of Japan.
12 by 18-inch, 4 coupled double-ender, Bisai Railway of Japan.
16.536 by 23.62-inch double-ender, side tank, Lung Wu Railway of China.
16 by 22-inch mogul, Kansei Railway of Japan.

The Westinghouse Electric and Manufacturing Company have received from their European branch notice of the award to them by the Metropolitan Electric Supply Company of the contract for a large electric lighting plant to be installed in London. The apparatus will be of the multiphase type, involving the use of the Tesla patents, which are owned in England by the Westinghouse Company. It is understood that the contract amounts to between $350,000 and $400,000.

Vice-President Voorhees, of the Philadelphia & Reading, has decided to put the locomotive department of the company's shops on six days a week, working until half-past four o'clock every Saturday afternoon.

The three European cities of Dublin, Ireland, and Barcelona and Madrid, Spain, are to be equipped with trolley systems. The contract has been closed with the British Thomson-Houston Company, of London. All the electrical and steam apparatus on the Dublin order, and all the electrical apparatus on the Barcelona and Madrid lines will be of American manufacture, the electrical apparatus being manufactured by the General Electric Company at Schenectady, N. Y., and the engines by The Edward P. Allis Company, of Milwaukee. For Dublin, the contract includes all the steam boiler and engine, dynamo and motor equipment sufficient for 150 cars. The Spanish contracts are for electrical equipment for running 140 cars. The contracts for engines by the Allis people call for six vertical cross-compound engines for Dublin, and tramway engines are also under contract for London, Sidney and Paris in addition to the orders already mentioned.

The Missouri Car and Foundry Company, St. Louis, Mo., has been incorporated for the purpose of doing a general foundry and car-building business. The capital stock is $2,000,000, and Messrs. William McMillan, W. K. Bixby, W. N. McMillan and James Connolly are interested.

The last of the order of 15 21 by 26-inch consolidation locomotives built by the Pittsburgh Locomotive Works for the Baltimore & Ohio Railroad have been delivered and are in service on the second division, between Brunswick and Cumberland. These locomotives excite very favorable comment by reason of their general design, excellent workmanship and efficient service, and are further evidence of the advance that is being made by the Baltimore & Ohio in its motive power. Thirty-five locomotives of this type have been placed on the second division during the past year, and with the reduction in grades and in the increase in power, the number of cars per train has been increased about 40 per cent.

The Baltimore & Ohio Railroad has greatly increased the number of its cars and locomotives equipped with air brakes and automatic couplers by the purchase of new equipment. The best showing is on freight cars. Owing to the dangers involved in their further use, 1,500 of the old iron hopper cars have been broken up.

Bids were opened October 21 in the office of Captain Shoemaker, chief of the revenue cutter service, for the construction of the new cutter authorized by act of Congress for service in and around New York, at a cost not exceeding $175,000. The specifications called for a vessel 1?? feet over all, 16.6 feet depth and 29.6 feet molded beam, with a displacement of 706 tons. The bidders were: Columbia Iron Works and Dry Dock Company, of Baltimore, $141,000; Gas Engine and Power Company, of New York, $151,800; Lewis Nixon, Elizabeth, N. J., $173,900; Charles Hillman Ship and Engine Building Company, of Philadelphia, $173,000. When this boat is completed there will be six new vessels in the revenue cutter service, all of them able seagoing boats of from 16 to 18 knots capacity.

Our Directory

OF OFFICIAL CHANGES IN OCTOBER.

Baltimore & Annapolis.—Mr. J. W. Brown has been elected President and General Manager, to succeed Mr. J. S. Ricker, resigned.
Chattanooga, Rome & Columbus.—Mr. A. W. Love has resigned as Master Mechanic.
Chattanooga, Rome & Southern.—Mr. C. B. Wilburn has been elected President of the reorganized company.
Chicago & Alton.—Mr. A. McCormick has been appointed Master Mechanic with headquarters at Slater, Mo.
Chicago & South Bend.—Mr. Peter E. Studebaker, Second Vice-President, died at Alma, Mich., at the age of 61 years.
Chicago, Rock Island & Pacific.—Mr. W. G. Purdy has been elected First Vice-President to succeed Benjamin Brewster, deceased, and Mr. W. H. Truesdale has been elected Second Vice-President.
Cincinnati, Hamilton & Dayton.—Mr. A. J. Ball has been appointed Assistant Superintendent of Motive Power and Machinery, with headquarters at Cincinnati, O. Mr. J. M Percey has resigned as Master Mechanic.
Cincinnati, New Orleans & Texas Pacific.—Mr. V. B. Lang has been appointed Master Mechanic, with headquarters at Chattanooga, to succeed Mr. P. H. Schreiber, deceased.
Colorado & Northwestern.—Mr. J. T. Blair has been appointed General Manager.
Denver & Rio Grande.—Mr. C. H. Quereau has been appointed Master Mechanic of the first division, with headquarters at Denver, Colo., to succeed Mr. W. H. V. Rosing, resigned.
Duluth, Missabe & Northern.—Mr. J. T. McBride has resigned as General Manager.
El Paso & White Oaks.—Mr. J. L. Campbell has been appointed Chief Engineer, with headquarters at El Paso, Tex.
Grand Trunk.—Mr. Charles M. Hays has been elected President; he was formerly General Manager of the Wabash.
Green Bay & Western.—Mr. A. Fenwick, Master Mechanic, has resigned.
Grand Trunk.—Mr. W. Aird has been appointed Master Mechanic and is in charge of the Montreal shops.
Green Bay & Western.—Mr. W. P. Raidler has been appointed Master Mechanic, with office at Green Bay, Wis.
Hendersonville & Brevard.—Mr. J. T. Rickman has been appointed General Manager, with headquarters at Hendersonville, N. C.
Illinois Central.—Mr. W. H. V. Rosing has been appointed Mechanical Engineer, to succeed Mr. H. A. Fritz resigned.
Illinois Central.—Mr. W. B. Baldwin has been appointed Master Mechanic, with office at McComb City, Miss.
Intercolonial.—Mr. W. B. MacKenzie has been appointed Chief Engineer, with office at Moncton, N. B.
Jamestown & Lake Erie.—Mr. Gerald Redmond has been elected Vice-President, with office at Jamestown, N. Y., to succeed Mr. E. T. Haines, resigned, and Mr. C. R. Van Etten has been appointed General Manager, with office at Jamestown, N. Y.
Kansas City, Pittsburgh & Gulf.—Mr. David Patterson, Master Mechanic of the Southern Division, has been transferred to the Northern Division, with headquarters at Pittsburgh, Kan.
Lehigh Valley.—Mr. John S. Lentz has been appointed Assistant Superintendent of Motive Power, with headquarters at South Bethlehem.
Mexican National.—Mr. J. W. Hall has been appointed Master Mechanic of the San Luis Division, with headquarters at San Luis Potosi, Mex., and Mr. W. F. Galbraith has been appointed Master Mechanic of the Southern Division, with headquarters at the City of Mexico.
Michoacan & Pacific.—Mr. W. H. Rice has been appointed Master Mechanic, with headquarters at Zitacuaro, Mex., to succeed Mr. H. A. O'Brien.
Philadelphia & Reading.—Mr. E. M. Humstone, Assistant Superintendent and Master Mechanic, has resigned. Mr. H. Schaefer has been appointed Master Mechanic. The office of Assistant Superintendent has been abolished.
Pennsylvania.—Mr. Joseph Wood has been chosen Third Vice-President, to succeed Mr. J. E. Davidson, deceased.
Peoria, Decatur & Evansville.—Mr. A. L. Davis has been appointed Chief Engineer.
Pittsburg, Bessemer & Lake Erie.—Mr. F. E. House has been appointed General Superintendent, with headquarters at Pittsburg, Pa.
Pittsburg & Lake Erie.—Mr. S. R. Callaway was chosen President at a recent meeting of the Board of Directors.
Rio Grande Western.—Mr. E. J. Yard has been given the title of Chief Engineer, with headquarters at Salt Lake City, Utah.
South Atlantic & Ohio.—Mr. E. M. Roberts has been appointed Assistant Superintendent and Master Mechanic, with headquarters at Bristol, Tenn.
Southern.—Mr. J. T. Robinson has been appointed Master Mechanic of the Anniston Division, with headquarters at Selma, Ala., in place of Mr. T. M Feeley, transferred.
Southern.—Mr. J. B. Gannon has been appointed Master Mechanic, with office at Louisville, Ky.
St. Louis Southwestern.—Mr. H. D. Galbraith has been appointed Foreman of the Machinery Department, with office at Texarkana, Tex., to succeed Mr. W. C. Mitchell, resigned.
Utah Central.—Mr. Charles E. Stanton has been appointed General Manager, with headquarters at Salt Lake City, Utah.
Wheeling & Lake Erie.—Mr. J. W. Sherman has resigned his position as Chief Engineer.
Wabash.—Mr. W. C. Buly has been appointed Master Mechanic; he is succeeded as Foreman of Shops by Mr. Herbert K. Mudd, at Delray, Mich.

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

DECEMBER, 1897.

CONTENTS.

Automatic Semaphore Block Signals—Illinois Central Railroad.

BY W. J. GILLINGHAM, JR., SIGNAL ENGINEER.

That portion of the Illinois Central Railroad lying between Carbondale and Cairo, known as part of the St. Louis Division, is an extremely busy line. It is the throat so to speak, through which the traffic from the Chicago, Amboy and St. Louis Divisions on the north and that from points south of the Ohio River passes. Until 1896 all this traffic was handled on a single track and the difficulties of operation and of the handling of business soon became so great that a second main track was constructed between the points mentioned.

The major portion of this work is through a country crossed by a spur of the Ozark Mountains, extending diagonally from northwest to southeast through the southern part of Illinois. The heaviest portion of the work is between Bosky Dell and Dongola, the gradients and curves being shown on one of the accompanying diagrams. It is of this section that this article treats in describing the system of block signals now installed and operated between Cobden and Makanda, and which are now being extended from Cobden to Dongola on the south and from Makanda to Bosky Dell on the north, a total distance of 28 miles.

After careful deliberation it was decided to use the standard semaphore and fittings, identical with those used in interlocking practice, except for certain modifications which were made to reduce friction by the introduction of ball bearings.

In 1894 the Illinois Central Railroad had erected in Chicago a semaphore automatic electric signal (which is still in service), for the purpose of experiment and to determine the reliability and efficiency of an exposed semaphore signal electrically operated. The signal is located on the shore of Lake Michigan, where it has been and is now subjected to severe and changeable conditions of weather, and the result of these tests fully justified the decision to adopt this type of signal on the St. Louis Division.

Preliminary to the undertaking of the outside work, plans were prepared showing grades and alignment and the signals were located with a special reference to the grades, bearing in mind the poise of a train in starting after having been stopped at a signal; the uniform length of blocks being secondary to the location with reference to the grades.

The locations having been determined on the plan, the next step was to make the ground locations with reference to the line of vision taking the grades into consideration.

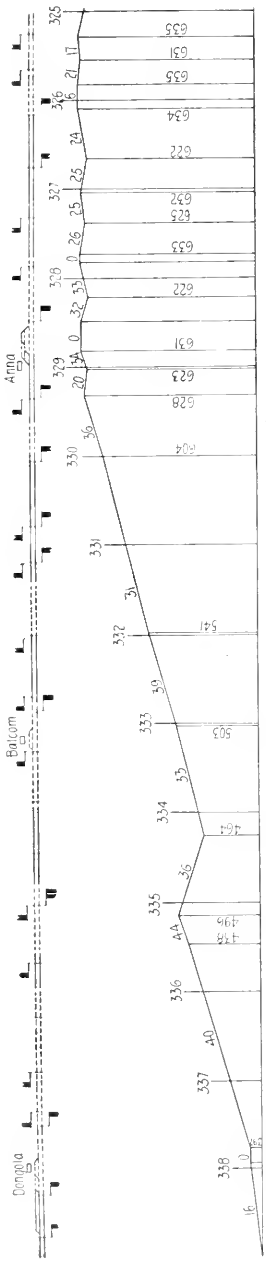
In determining these locations the division officers and signal department co-operated; and it may be of interest to note here that in no instance was there a necessity for variation in excess of 200 feet from the original location, and but four instances were found where the home signals could not be sighted from a sufficient distance, thus indicating the care with which the signals were located. As previously stated, the blocks are not of equal lengths, but at the stations and groups of switches home and advance signals have been placed uniformly, the home signals permitting trains to pull into stations to work when the block in advance is occupied, the advance signal being placed far enough ahead of the switches to permit of the longest train switching without interference or delay when the block next succeeding is occupied.

The complete application extending from Bosky Dell to Dongola consists of 56 signals, electrically operated and controlled, all being of the standard semaphore type. The accompanying diagram, showing the arrangement of circuits and locations between Makanda and Cobden, illustrates the circuits followed throughout the entire application, but the complications are such that a diagram of a single block is shown with the following explanation to insure a clearer understanding.

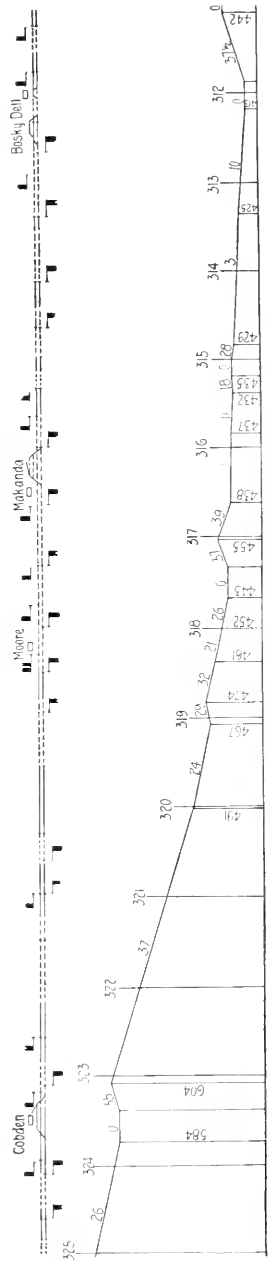
A B, *B C* and *C D* are sections of track constituting a block between *B* and *D*. *R* 1, *R* 2, *R* 3, *R* 4, are track relays; *M* and *M* 1 are relays directly controlling the motor circuits, *B* 1 and *B* 2 are the batteries operating the motors, *B* 3 is a battery for operating the bells, and *B* 4 is a battery for operating the relays *M* and *M* 1. All the track relays are normally closed and the relays *M* and *M* 1 are normally open. The entrance of a train on section *A B* shunts the track battery from track relay *R* 1, closing the path for battery *B* 4 through the back contact point of relay *R* 1 and thus energizing relays *M* and *M* 1. The energizing of relay *M* closes the front contact on that relay, thus completing the circuit for battery *B* 1 through this contact and the home signal motor clearing this signal. A similar result obtains with relay *M* 1, battery *B* 2 and the distant signal. When the home signal is in the clear position a circuit is closed through the "circuit-closer" battery *B* 3 and bell magnets, causing the bells to sound. When the train enters section *B C* the relay *R* 2 is demagnetized and the distant signal resumes the caution position on account of the breaking of circuit for battery *B* 2 by opening the front contact of this relay; the train entering section *C D* demagnetizes relay *R* 3 and the home signal resumes the stop position by reason of breaking the circuit of battery *B* 1 through the opening of the contact point on relay R 3. It will be noticed that the home signal is in the stop position and the "circuit-closer" open, but the bells will continue to sound so long as the train is in section *C D*. This is accomplished by a circuit completed through the back contact point of *R* 3 battery B 3 and the bell magnet coils. The train having passed out of section *C D* all apparatus is restored to the normal condition.

Each block section is provided with a distant and home signal and an advance signal at stations. Each switch is provided with a vibrating bell. The signals are normally in caution and stop positions. A train approaching the distant signal will, upon entering the preliminary section (assuming the block in advance to be unoccupied), clear the advance, home and distant signals. Should any switches be located in the block the vibrating bell will sound simultaneously with the entrance of the train on the preliminary section. If, however, the block controlled by the advance signal is occupied the signals are not cleared by the train on the preliminary section, but the home signal clears and the bell sounds immediately upon train passing the distant signal.

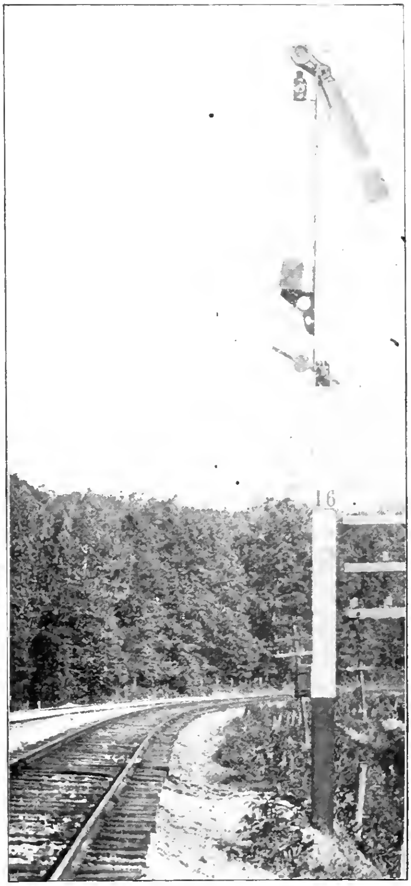
The application of vibrating bells at switches was first made on the Chicago terminal of the Illinois Central Railroad, and while it is true that theoretical objections have been made to



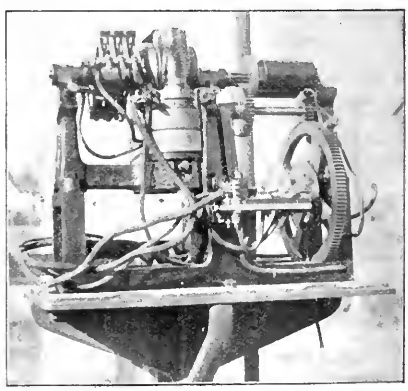
Profile and Signal Plan. (This view joins the one below it.)



Profile and Signal Plan. (This view joins the one above it.)

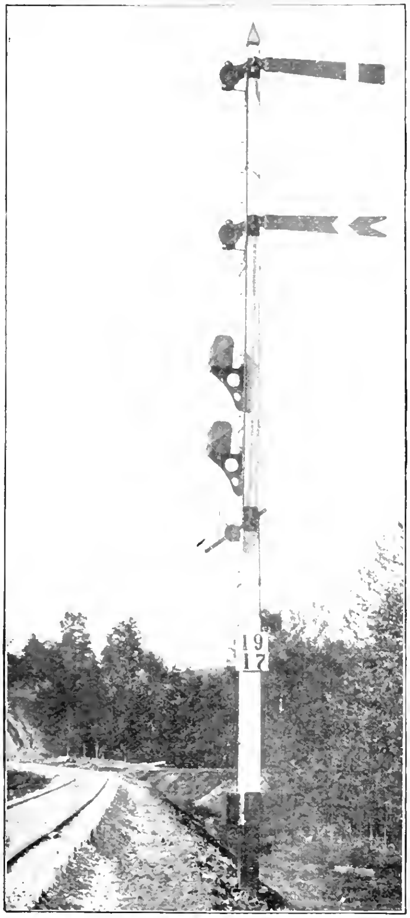


Home Signal "Cleared."

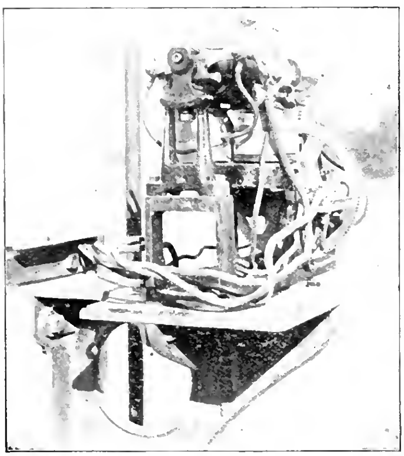


Front View of Motor.

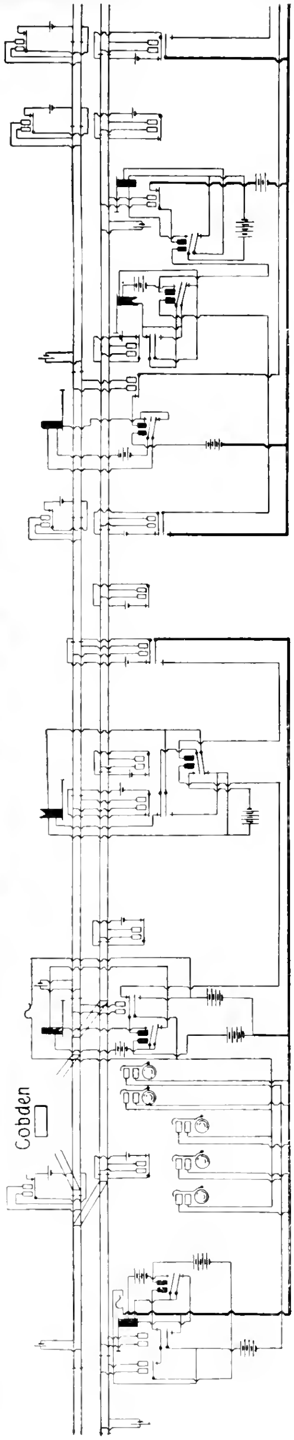
AUTOMATIC BLOCK SIGNALS—ILLINOIS CENTRAL RAILROAD.—W. J. GILLINGHAM, JR., *Signal Engineer.*



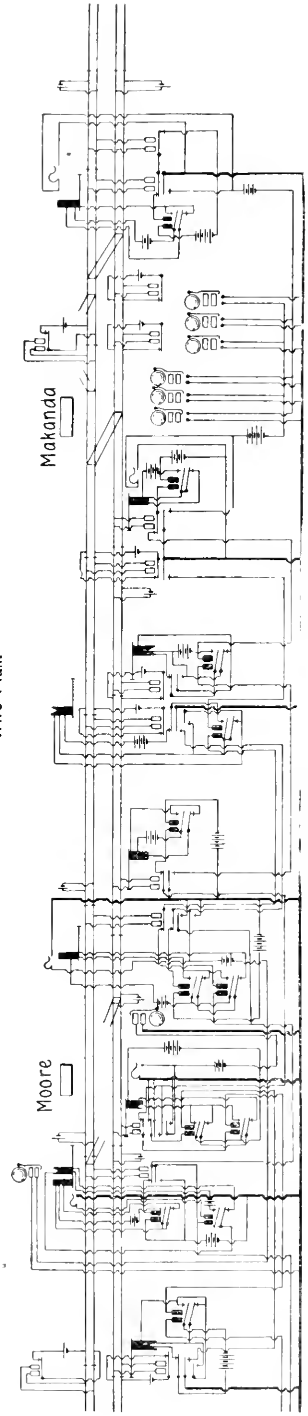
Home and Distant Signal.



Side View of Motor.



Wire Plan.



Wire Plan. (This view joins the one above it.)

AUTOMATIC BLOCK SIGNALS—ILLINOIS CENTRAL R. R.—W. J. GILLINGHAM, JR., *Signal Engineer.*

their use, from a practical standpoint they would seem to be more efficient than visual indicators, not only because they are more arrestive but because they give indication or warning to a greater number of trainmen. Instructions governing crews using main-line switches within the block system are very explicit. Trainmen are not permitted to move a switch for the passage of a train from side track to main track or from one main track to the other when the bell at such switch is sounding; nor to proceed after reversing a switch for the siding unless the bell does sound. It is apparent, therefore, that if, in opening the switch, the bell does not sound, the necessity for extra precautionary measures is suggested and trainmen are governed accordingly.

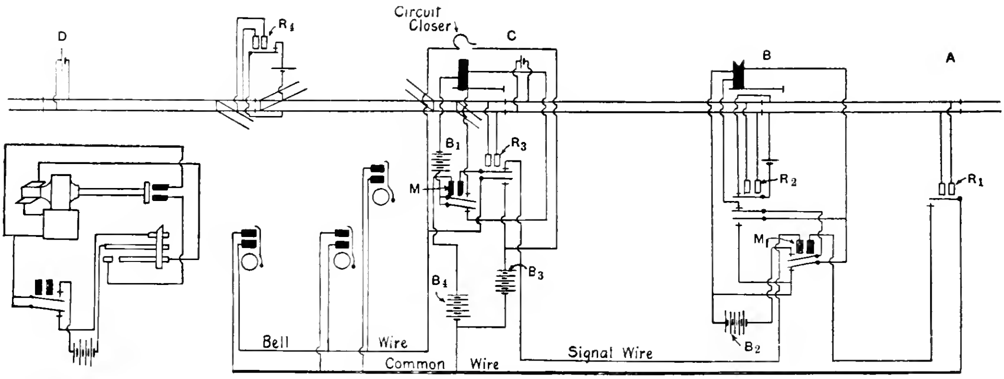
The apparatus for operating the signal directly, necessarily differs from that operating disc signals, and in its simplicity of construction, the likelihood of failure to perform its function is very remote, in fact is no greater than with disc signals with which less battery is required.

The distinctive features of the system are the method of bonding the rails for the track circuit, the use of vibrating bells at switches, and the manner in which the semaphores are operated. Until quite recently the practice has been to bond the joints by fastening the wires to the base of the rails, but this has not proved altogether satisfactory, for the reason that the bonds are forced out or broken, either by contact with the ties or shearing off by the spikes, due to creeping of the rails. So much trouble was experienced from the latter cause on the approaches to the Cairo bridge that it became necessary to provide some other form of bonding to insure satisfactory results. The method now pursued both on the bridge and St. Louis division work is to bond through the web of rail using two wires in substantially the same manner as applied on electric street railways. This obviates, entirely, the troubles experienced in the other method and reduces the cost of maintenance in the form of replacements.

In the operation of the semaphore a one-sixth horse-power motor is used, the power necessary to operate it varying (according to the resistance of the circuit) from 10 to 16 cells Edison Lelande Type S Battery. The motor, as will be seen from the accompanying illustrations, is fastened to the side of the signal pole, directly above the counterweight lever. Attached to this lever is a standard cable ¼ inch in diameter, the other end of which is fastened to a drum keyed to a shaft geared into the armature shaft as 25 to 1. The drum shaft is provided with a worm into which is geared a circuit closing device for controlling the motor and brake circuits. On one end of the armature shaft a soft iron circular disc is fastened, which, in connection with a high resistance coil, acts as a brake to stop the motor, there being lateral movement enough in the shaft to permit of the disc being attracted and held by the brake coils when they are energized. On the base supporting the motor are insulated strips forming a part of the circuit-closing device. The action of this circuit-closing device is such that when the block is unoccupied and no train in the preliminary section, the battery circuit is open. When a train enters the preliminary section a circuit is automatically closed through the motor, which thereupon causes the signal to assume its clear position. Immediately before the signal reaches the clear position the motor circuit is automatically broken, and a circuit is closed through the brake magnet coils, causing a retardation of the movement of the arm and bringing it without undue shock against the stop where it is held by the brake magnet. In this connection it should be understood that the circular disc is never in contact with the brake magnet poles, the brake being purely magnetic and not a friction device, thus preventing any possibility of sticking due to residual magnetism. The signal remains in the clear position until the first wheels of the train enter the block, when the brake magnet circuit is broken and the signal returns to the stop position; its speed, however, being retarded just before the signal arm reaches the stop by the counter current developed in a circuit at that time automatically closed through the motor only.

In considering the application of automatic signals generally, the important question is to determine their reliability and efficiency as an adjunct to the safe and prompt handling of trains. With an inclosed system the apparatus directly controlling the signal is not subjected to changes of atmospheric conditions to any great extent, and the question of a normally danger or normally clear system becomes one of preference rather than the superiority of the one over the other. With a semaphore system, however, the conditions are somewhat changed and it becomes not a matter of preference but one of expediency that the signals should be normally at danger. The actual time a signal is in the clear position (for train movements) is very much less than that spent in the danger position; this will vary with volume of traffic. Assuming it to be relatively as one to five the failure of apparatus should be on the side of safety, and the tendency of the signal arm to stick in sleety or snowy weather is certainly in the position at which it is the longest time at rest. It is manifestly true therefore, in contending against such possibilities, that the failure to operate from the stop or danger position is infinitely more desirable than the failure to operate from the clear position. It may be argued that the conditions cited are remote and not likely to occur, but whether this be true or not the principle of such a system being normally at danger is correct, and certainly presents no obstacle in its economical and successful operation.

It has not been the purpose of the writer to describe in this article the minor details of the application, but as a matter of information it may be stated that No. 8 E. B. B. iron wire is used for the line placed on telegraph poles, and that all batteries are



Motor Circuits.

Block Circuits Simplified.

placed underground, those for the track circuit in cast-iron chutes and for the motors and switch bells in cedar tubs specially made for the purpose.

In conclusion it may be stated that the cost of maintenance and operation of these signals, so far as we have been able to judge from our experience up to this time, will be but slightly, if at all, greater than that of the disc system.

Car Lighting by Electric Storage Batteries — C., M. & St. P. Ry.

The system of direct car lighting by electricity used by the Chicago, Milwaukee & St. Paul Railway is familiar to our readers, and it is of interest to note the recent introduction of storage batteries on several cars of the trains of that road running between Chicago and Denver.

On Sept. 12 of this year arrangements were made to run through sleeping cars from Chicago to Denver, in connection with the Chicago, Rock Island & Pacific, from Omaha to Denver. To make these sleepers as attractive and comfortable as possible, two of the best twelve section cars were used and fitted with electric storage batteries and lights.

The cars are equipped with 34 50-volt 16-candle power lamps, and four nights are occupied on the road. To meet this extraordinary demand for light the largest capacity battery, with such weight as could be handled, was decided upon.

This battery, the "Selvey" patent, made at Dayton, Ohio, weighs 96 pounds per cell and has a rated capacity of 400 ampere hours. Three sets of 26 cells each were purchased. One set of 26 cells is used under each car. These are carried in four trays all connected in series, and the terminal wires, four in number, three positive and one negative, are carried up into one of the closets where the switches are located. A simple but an ingenious arrangement is provided, by which the lamps can be turned on or off, batteries charged, or discharged, or in case of broken circuit cut out entirely, and the car lighted in the usual manner from the dynamo situated in the baggage car.

When the 26 cells are fully charged they give a combined voltage of 57.2, which is too high for 50-volt lamps to stand economically and two cells are cut off. The terminals from these are led up to the switch box, where they are connected to the three-point switch, No 3. The first point to the left gives twenty-four cells in series, or 52.8 volts; the second or middle point 25 cells, or 55 volts; the third point to the right gives 26 cells, or 57.2 volts, the arrangement of the circuits being clearly shown in the diagram.

In service the lights are started with the switch on the first point, and as the voltage lowers to 50 from using the lamps, the switch is moved one point at a time until the two extra cells are cut in, and in this way the candle power of the lamps is maintained up to the normal throughout the trip.

In the yard at Western Ave., Chicago, a small storage house has been built and equipped with automatic cutout switches and meters. Also a variable resistance is provided by means of which the extra set of batteries is charged at night from the dynamo that lights the freight buildings situated at this point. The cars arrive every other day, so the batteries are charged during two nights.

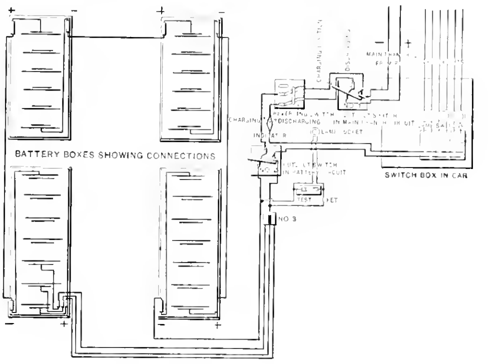
A nightly report of the time and number of amperes is kept and returned to the office of the electrician each morning, also a daily report is received from the electric light inspector, and from the porter of the car, so that reliable information is at hand at all times to enable the electrician to keep track of the performance of the batteries.

On the return trip the cars come from Omaha to Chicago on the electric-lighted train, having the direct system. If batteries have been run down by the use of an extra amount of light, they can be thrown into circuit with the lamps of this train and may be charged through them. This does not give satisfactory light, however, unless the batteries are about fully discharged, or to 46.8 volts or 1.8 volts per cell. In this case the lamps burn at about their normal candle power. As the cells become charged and the voltage rises the candle power of the lamps decreases. As soon as this is noticeable the porter throws switch No. 1 to the charging position and takes current for the lamps from the batteries. In this way standard candle power may be had on the lamps at all times.

Owing to the time these cars are on the road and the inexperienced attendance they would receive while en route, it was with a good deal of doubt that they were equipped with storage batteries. The experiment has not been carried far enough to enable the officers to say that it is an entire success, nor can they give the entire cost of repairs and maintenance. However, the cost of charging and attendance at Chicago is stated to be as follows:

Charging, fuel per trip (two nights)	$1.10
Attendance	60
Total per trip (four nights)	$1.70

The installation of these batteries and the equipping of the cars was done by the employees of the railroad company at the yards in Chicago, also the designing and manufacture of the various switches and automatic cutouts was done at the shops at West Milwaukee under the personal supervision of the electrician, Mr. C. R. Gilman.



Storage Battery, Car Lighting Circuits.

The following, which is taken from the instructions issued to the porters of the cars, explains the method of using the storage battery system and the manipulation of the switches in connection with the direct system on the line east of Omaha:

Instructions to porters:

After your car has been attached to the Rock Island train at Omaha, and light is required, throw switch No. 1 to discharging position and turn on lamp switches in switch box.

In the morning turn off lamp switches in switch box. The following night, turn then on, and off again in the morning. During the evening and night, turn out as many lights as possible without interfering with the comfort of the passengers.

On the return trip after the car has been attached to C., M. & St. Paul train No. 4, inspector will throw switch No. 1 to *charging* position. When you arrive at Manilla, or any station where engines are changed, or switching is done, just as lights go out throw switch No. 1 to *discharging*. That will light your car from the batteries and not leave it in darkness.

As soon as new engine is attached and light is again on the train and your car connected, throw switch No. 1 back to *charging* position. Be careful to do this every time that engine is exchanged, or your car is cut off train for any purpose.

After the inspector has taken the voltage of the batteries leaving Omaha he will tell you if the voltage is high, and if so leave switch No. 1 on discharging position burning lamps from batteries. Later on when lights begin to grow dim throw switch No. 1 to *charging*. If, however, they should continue bright, wait until the passengers have retired.

When you get Denver sleeper at Chicago, switch No. 3 will be thrown all the way to the left. The second night (Omaha to Denver) if the lights get a little dim, throw switch No. 3 to center position and light will burn brighter. The third night (Denver to Omaha) when they grow a little dim, throw switch No. 3 all the way to the *right* and leave it there, this will again make them burn brighter.

We are indebted to Mr. J. N. Barr, Superintendent of Motive Power, and Mr. C. R. Gilman, Electrician of the road, for this information.

Locomotive "Sparks" for Fuel in Electric Power Stations.

BY EDWARD C. BOYNTON, M. E.

A prominent English railway official, while watching the burning of sparks at one of the power stations, of the New York, New Haven & Hartford Railroad, remarked: "You tell me that this stuff has been already burned in your locomotives, and you are again burning it; now, pray tell me who burns it after you get through with it?"

The fact that the road referred to is using sparks as fuel, to generate electric power, has been mentioned in a general way by several of the technical papers and the daily press, but it will doubtless be of interest to many to know the details of the practice.

Many attempts have been made in the past to burn sparks, but with indifferent success, and vast quantities are daily going to waste. The exact chemical composition of sparks is not now known, though they are believed to be almost wholly carbon. They are so fine that they lie on the grate bars in a compact mass, and it is impossible to burn them by means of natural draft. A forced draft must be used, and it must be powerful enough to force the air up through the mass, and keep it in a more or less distributed condition. In practice this is clearly seen on looking through the open furnace door, when the whole top of the fire is seen in violent motion, the burning sparks jumping up and falling back in a continual shower.

The sparks are fed into the furnace exactly as they come from the extension front of the locomotives, not mixed with anything else. Experience has proved that it is not best to mix them with coal, as it greatly increases the difficulty of firing. They make an exceedingly hot fire, which, however, must be cleaned at intervals of three or four hours. This is necessary because the thickness of the fire increases rapidly, due to the great quantity of fuel fed into the furnace and the layer of ashes and clinker which accumulate on the grate must be removed. One furnace is cleaned at a time, and with the aid of the blower, the fire can be brought up to the required temperature in a remarkably short time. This is a great advantage, as it enables a fireman to carry an even steam pressure all through the process of cleaning. The extremely fluctuating load due to electric railway work makes the firing much more difficult than it is under ordinary stationary boiler conditions, and in order to produce an even steamline on a recording gauge, a fireman must learn to fire sparks, no matter how good a coal fireman he may be. The weight of sparks required for the evaporation of a given weight of water, as taken from a number of tests, may be said to be about double that of coal.

Several important departures from ordinary boiler practice have been found necessary to insure success in burning sparks, the first of which is in the boiler setting. The boilers used by this company are of the ordinary horizontal flue type, 72 inches in diameter and 19 feet long and contain 130 3-inch tubes. Extending across and resting on top of the brick settings, at right angles to the boilers, are two pairs of heavy channel irons. From these, four heavy iron rods extend down to the sides of each boiler, two on each side near the ends of the boiler. These rods hook into lugs riveted on the sides of the boiler, at the center line. The boilers are thus suspended from four points, and all movement due to expansion or contraction is provided for in this manner.

A so-called "exploded idea" is also brought into successful use in placing the boiler so that the bottom of the shell is 48 inches above the grate bars, while the top of the bridge wall is only 18 inches above them. As a result of this, a very large combustion chamber is secured, the purpose and effect of which is to allow all the gases of combustion to become thoroughly ignited before entering the tubes. That this is of great advantage is shown by the very low temperature of the gases in the smoke flue after leaving the boilers. This temperature averages about 35 degrees above that of the steam. The furnace is six feet wide and seven feet long, making 42 square feet of grate surface. For convenience in cleaning fires, about two feet of the grate, nearest the bridge wall, is arranged to turn over and dump into the ash pit, by means of levers. The type of grate bar used is the well-known "herring-bone," with openings about three-eighth-inch wide.

One of the most interesting details is the peculiar forced draft, because of its bearing on the burning of sparks. This part of the equipment consists of a cast-iron cylinder or pipe about nine inches in diameter and two feet long, bell mouthed at one end. This extends through the boiler front into the ash pit, either between the ash pit doors or through one of the doors. The bell mouth projects outward and in it is a hollow brass ring, seven inches in diameter and nearly elliptical in cross-section. On the inner edge of this ring are 20 small holes $\frac{1}{16}$ inch in diameter. There is a steam connection to this ring, and when steam is turned on the result is a large number of fine steam jets blowing through the pipe into the ash pit, and drawing with them a large quantity of air through the bell-mouthed opening. The air is considerably heated by the steam after it enters the ash pit, and the sparks get what they require for perfect combustion—oxygen and hydrogen to combine with the carbon they contain. While the boilers are in service the main damper is set so as to be kept nearly closed by the automatic regulator when full steam pressure is on, and it opens very little when the pressure falls. The object of this is to confine the gases and allow them to escape into the chimney very slowly.

A peculiarity about this method of burning sparks, and one that requires the constant attention of the fireman, especially when cleaning a fire, is that, if the steam pressure gets started downward, it is likely to continue going down so far that it is very difficult to restore it again without stopping the engines. This is due chiefly to the fact that the efficiency of the blower decreases rapidly with the falling steam pressure. With careful firing, however, this never occurs. The regular steam pressure carried with light loads is 100 pounds, but 125 pounds is carried at full load. The number of men required to fire a battery of boilers burning sparks is the same as would be required for coal.

The weight of sparks consumed per electrical horse power hour averages six pounds at a cost of about two mills.

This cost refers only to freight charges for loading and hauling its sparks to power stations. The power consumption refers to an ordinary track with no steep grades or sharp curves. The speed is about 30 miles per hour when using the above power. An electric train seating about two hundred persons and weighing 62 tons requires 36 pounds per train mile at a cost of 12 mills. The power developed by the motors is about $\frac{13}{100}$ horse power hour per ton mile.

The New Railroad in Alaska.

The Trenton Iron Company has recently taken a contract for a portion of a new railroad which will soon be built in Alaska. The contract is with the Chilkoot Railroad and Transport Company for the construction of a Bleichert aerial wire rope tramway, to have a capacity of 50 tons per day, for the transportation of passengers and freight over the Chilkoot Pass, and the work is now being pushed as rapidly as possible. One carload has already been despatched and others will follow. The company doing this work is an organization of gentlemen connected with the large steamship lines and the Northern Pacific Railroad at Tacoma. Messrs. Dodwell, Carlill & Company, representing steamship lines to China and Japan, also to Alaska, are among the interested parties. Mr. Hugh C. Wallace is President, and Mr. A. McL. Hawks is the Chief Engineer, and is now engaged on the work of construction. The first section, which will be a surface railroad, will extend from tidewater to the mouth of the canyon, a distance of some eight or ten miles; from there on and up through the canyon and over the Pass the Bleichert aerial tramway will be put up, the northern terminus being at the head of the chain of lakes which afford the means of water transportation to the head of the Yukon River. The projectors of this work expect to have it completed this winter, and to be in readiness to receive freight and passengers as soon as the season opens in the spring, when it is estimated that there will be a great rush of miners and their outfits bound for the Klondike gold camps. We are indebted to the officers of the Trenton Iron Company of Trenton, N. J., for this information.

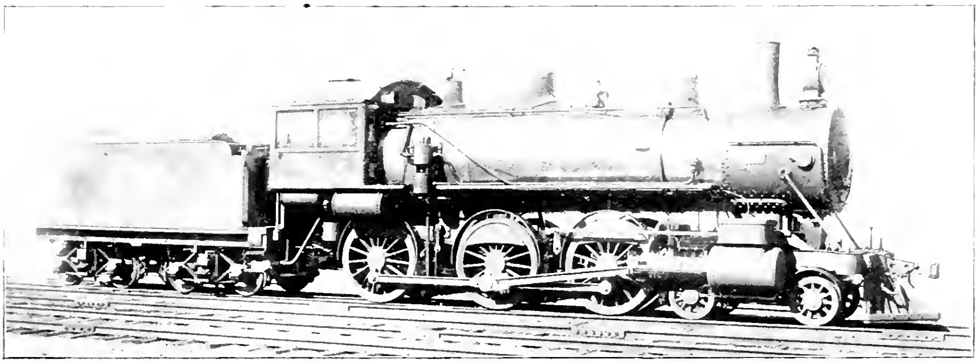
Ten-Wheel Freight Locomotive—C. & N. W. Ry.

Several of our contemporaries have presented meager descriptions of a new design for 10-wheel locomotives recently built by the Schenectady Locomotive Works for the Chicago & Northwestern Railway, but as we prefer to publish more than mere pictures we waited for some of the interesting details and for the service records before publishing a description of a design of such merit.

The order was for 10 locomotives, all of which have been finished, and they are doing excellent service. This design does not embody any novel features, but it does comprise excellent combinations which go to make up a good locomotive which will haul heavy loads, and, we believe, will haul them economically. The chief feature of the design is high boiler power and strength of parts which should enable the locomotives to avoid the failings of many as to breakdowns on the road. The boilers resembled those of the heavy eight-wheeled passenger engines for this road (illustrated on page 4 of our issue of January of last year) and a comparison will be interesting. The freight engines have 118,000 pounds weight on driving wheels as against 78,000 pounds of the passenger engines, and this necessitated the selection of the ten-wheel type for the new design. The grate is about six inches longer, and while the heating surface of the earlier boiler is 1,903 square feet, that of the new one is 2,311 square feet. The boilers of the freight engines are about two inches large in diameter and 2 feet 6 inches longer.

In order to strengthen the fastenings of the cylinders to the smoke arch a double row of bolts has been used extending all the way around the saddle casting and the joint is further strengthened by the use of a ¾-inch liner inside the smoke arch, which is riveted to the arch and takes the saddle bolts. The two rows of bolts in the back of the arch pass not only through the saddle casting and the smoke arch sheet but also through the smokebox ring which makes a very strong job of this part of the joint. The cylinder saddle is strongly ribbed and flanged in all directions. The frame is, as usual, double at the front end and is made very strong. To show the care which has been taken to keep the engines out of the shop as much as possible it should be noted that the flanges of the cylinder saddle extend beyond the casting itself far enough to receive a short vertical bolt through each rail of the frames outside of the walls of the saddle at the front and back. It is proper to say that cylinder and saddle castings would not fail so often if such precautions were generally taken.

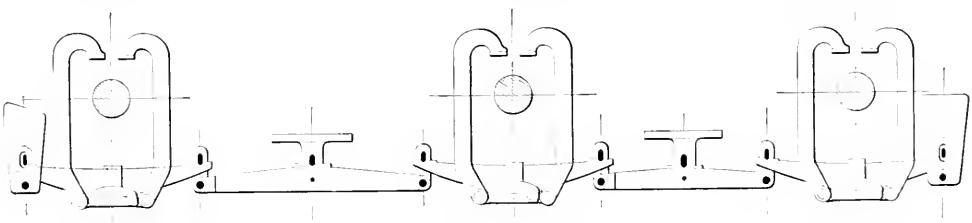
The guides are of the four bar style, which is unusual in 10-wheel engines. The links have a short radius, and the rocker and links are back of the driving wheels, which requires a long valve stem. This is made of heavy pipe, hollow and with the ends welded in. This plan gives short and straight eccentric blades which are to be desired and are much better than the long, springy, crooked ones that were formerly so often used on engines of this type. As the link radius is 46 inches long the increase of lead is not excessive.



Ten-Wheel Freight Locomotive—Chicago & Northwestern Railway.

The driving boxes are extra heavy. The journals are 8½ by 11½ inches. Cast steel is used for the wheel centers, for the foot plates, expansion knees, guide yoke knees, rocker and frame filling blocks, spring saddles and spring seats.

The spring rigging is not new with this design, but it is well worth putting on record. The driving-wheel brake is worthy of special mention because the brake levers are vertical and the lower ends are tied across the engine by the brakebeams, the result to be expected being freedom from swinging and swaying. There are two air-brake reservoirs, one under each running board, and the air pump discharges into one of them, from which the air passes into the other, giving a large main reservoir capacity with the additional advantage of being able to secure dry air from the second reservoir.



Arrangement of Equalizers and Springs.

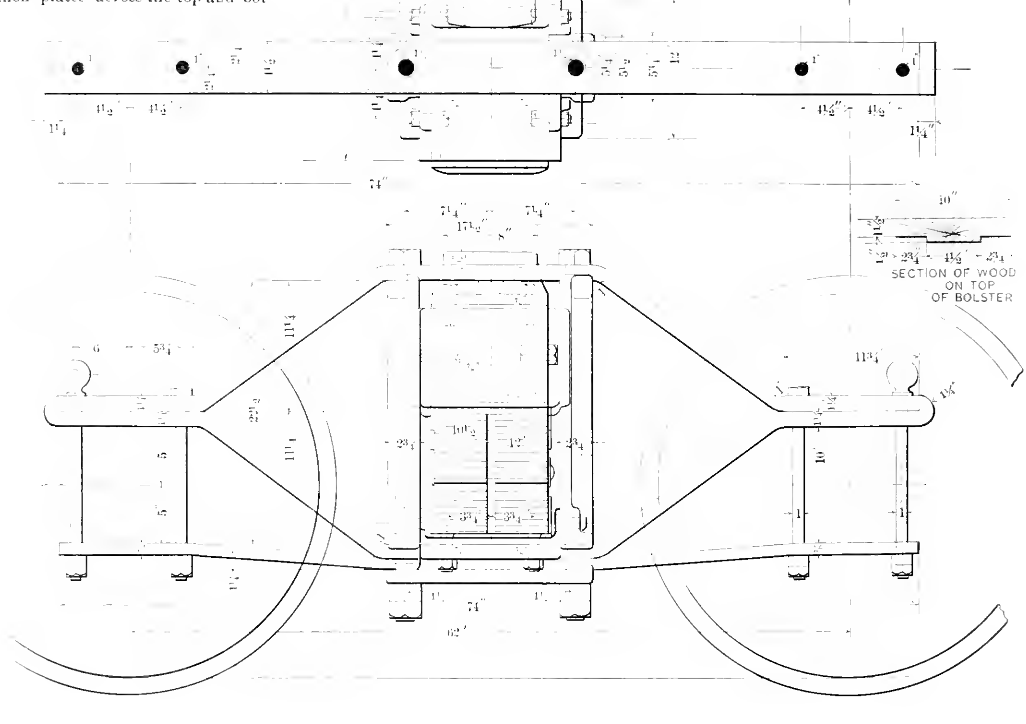
The drawing of the tender draft rigging shows its construction without extended explanation. It employs the regular car coupler with tail strap, and a car coupler may at any time be used for repairs in case of an emergency. There are no springs in the draft gear. A heavy follower is used and the space in the tail strap is filled by two round-faced blocks, upon which the coupler pivots at that point. A lateral motion of 1½ inches is provided between the coupler and the carry iron on each side;

this is used for freight service only, more space being provided for passenger service. The coupler has only $\frac{1}{8}$-inch slack between it and the buffer plate, which is let into the sill: the slack of the follower is somewhat more than this, so that the buffing is taken wholly on the buffer plate in the end sill and the pull is of course taken by the draw casting.

The tender trucks are of special interest and the drawing shows the construction in detail. Attention should be called to the unusual depth of the arch bars, $22\frac{1}{2}$ inches, and the construction of the bolster and the spring plank. The bolster is of 8-inch channels with $\frac{7}{16}$ by 10-inch plates across the top and bot-

other 19-inch engines, on the division where the new engine was tried, is 900 tons. On another occasion one of the new ones pulled 8 loaded and 30 empty cars weighing 837 tons exclusive of the caboose from Belle Plain to Boone, where the other 19-inch engines are rated at 630 tons. There is a 58-foot grade and several sharp curves in this section.

The advantage of the ample weight on driving wheels is seen in the fact that with 190 pounds of steam and the reverse lever in full gear the wheels did not slip though sand was not used; the rail, however, was in very good condition. The advantage of the great heating surface is seen in the fact that in the heaviest work referred to the pop valves were blowing and the fire door was kept open. This heating surface is sufficient to take up the heat, while the greatest amount is being generated without raising the smokebox temperature



Plan and Elevation of Tender Truck.

tom. The springs are of the elliptic pattern and from the front elevation of the truck it will be seen that the springs may be removed very easily. The spring plank is a 12-inch channel with wooden filling piece. The design of the truck is an unusually strong one, which compares very favorably with the other features of the engine.

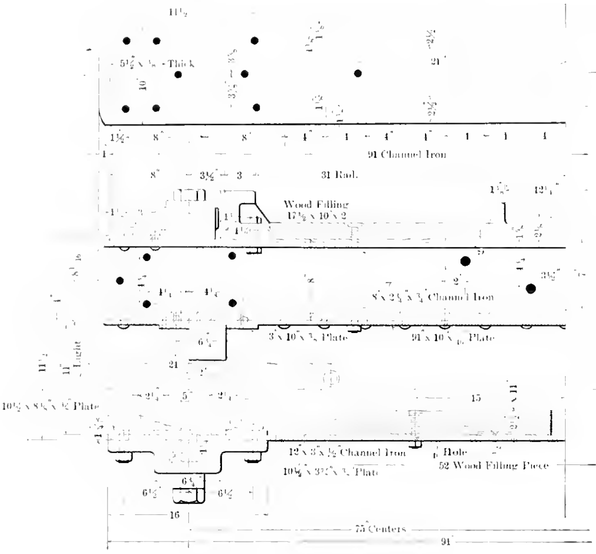
These engines are to be used on the Galena and Iowa divisions running between Chicago and Council Bluffs. The larger number of them will be used on the Iowa division, where the grades are heavier than those of the Galena division. The engines are doing excellent work. They have about 20 per cent. more hauling capacity than the best 19 by 24-inch engines on the road, and while no attempt has been made to ascertain their maximum capacity, they have shown themselves to be able to pull 1,138 tons, of which about 80 per cent. was in empty cars, while the rating of

to an unusual extent. The great power obtained from the large heating surface is very desirable, but the most valuable feature is the superior economy which it will give in every-day working.

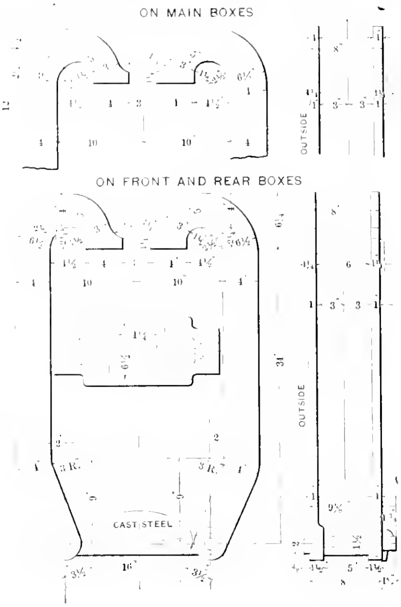
We present the following table giving the leading dimensions:

GENERAL.

Wheel base, total of engine	25 feet 10 inches
" " driving	14 feet 10 inches
" " total (engine and tender)	51 feet $8\frac{1}{4}$ inches
Length over all, engine	38 feet $4\frac{3}{4}$ inches
" " " total, engine and tender	60 feet $4\frac{3}{8}$ inches
Weight on drivers	118,000 pounds
" " truck wheels	38,000 pounds
" total	156,000 pounds
" tender loaded	93,500 pounds
Height, center of boiler above rails	8 feet 5 inches
" of stack " "	14 feet 9 inches
Heating surface, firebox	152.6 square feet
" " tubes	2,158.3 square feet
" " total	2,310.9 square feet
Grate area	28.65 square feet



Truck Bolster and Spring Plank.



Spring Seat and Hangers.

WHEELS, JOURNALS AND CRANK PINS.

Drivers, diameter .... 63 inches
" material of centers .... Cast steel
Truck wheels, diamer .... 30 inches
Journals, driving axle, size .... $8\frac{1}{2}$ inches diameter by $11\frac{1}{2}$ inches
" truck " " .... 6 inches diameter by 10 inches
Main crank pin, size .... $5\frac{1}{2}$ inches diameter by 6 inches

CYLINDERS.

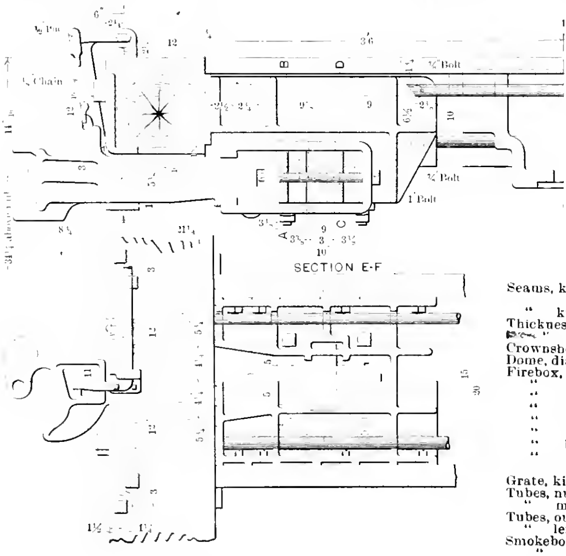
Cylinders, diameter .... 19 inches
Piston stroke .... 26 inches
" rod, diameter .... $3\frac{1}{4}$ inches
Kind of piston rod packing .... Cryster metallic
Main rod, length center to center .... 10 feet $6\frac{1}{2}$ inches
Steam ports, length .... 16 inches
" " width .... $1\frac{5}{8}$ inches
Exhaust ports, length .... 16 inches
" " width .... 3 inches
Bridge, width .... $1\frac{3}{8}$ inches

VALVES.

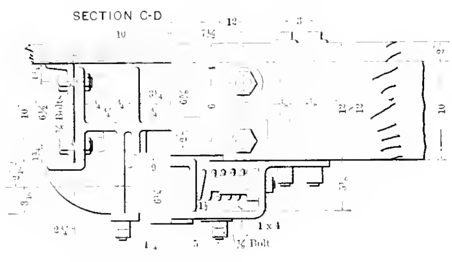
Valves, kind of .... Allen-American
" greatest travel .... $5\frac{1}{2}$ inches
" outside lap .... $\frac{7}{8}$-inch
" inside lap or clearance .... Line and line
" lead in full gear.. $\frac{1}{16}$ inch blind full gear forward; $\frac{3}{16}$-inch blind full gear back motion with about $\frac{1}{32}$ lead at 6-inch cut-off forward motion

BOILER.

Boiler, type of .... Extended wagon top
" working steam pressure .... 190 pounds
" material in barrel .... Carbon steel
" thickness of material in barrel .... $\frac{5}{8}$ inch and $\frac{11}{16}$-inch
" diameter of barrel, inside .... 63 inches



Tender Draft Gear.



Seams, kind of, horizontal.. Butt joint, sextuple riveted, with welt strip inside and outside
" kind of, circumferential .... Double riveted
Thickness of tube sheets .... $\frac{1}{2}$-inch
" " crownsheet .... $\frac{3}{8}$-inch
Crownsheet stayed with .... Radial stays 1-inch diameter
Dome, diameter .... 30 inches
Firebox, length .... 8 feet $6\frac{3}{16}$ inches
" width .... 3 feet $4\frac{3}{8}$ inches
" depth front .... $79\frac{3}{4}$ inches
" " back .... $67\frac{1}{4}$ inches
" material .... Carbon steel
" thickness of sheets .... $\frac{5}{16}$, $\frac{3}{8}$, $\frac{1}{2}$-inch
" brick arch? .... Yes
" water space, width; front, $4\frac{1}{2}$ inches to 5 inches under tubes; sides, 4 inches; back, 4 inches
Grate, kind of .... Rocking Railroad Company's style
Tubes, number 295
" material .... Charcoal iron
Tubes, outside diameter .... 2 inches
" length over sheets .... 14 feet 2 inches
Smokebox, diameter .... $67\frac{1}{2}$ inches
" length .... $71\frac{1}{2}$ inches

MISCELLANEOUS PARTS.

Exhaust nozzle, single or double .... Single

Exhaust nozzle	Permanent
" " diameter	4¾ inches, 5 inches and 5¼ inches
Netting	Perforated plate
" size of mesh or perforation	1½ inches by 3/16 inch
Stack, straight or taper	Taper cast iron
" least diameter	14 inches
" greatest diameter	16½ inches
" height above smokebox	3 feet 6½ inches

TENDER.

Type	Swivel
Tank capacity for water	4,500 gallons
Coal capacity	8 (2,000 pounds) tons
Kind of material in tank	Steel
Thickness of tank sheets	¼-inch and 3/16-inch
Type of underframe	10-inch steel channels
Type of truck	4-wheel
Truck with swinging motion or rigid bolster	Rigid
Type of truck spring	Double elliptic
Diameter of truck wheels	33 inches
Diameter and length of axle journals	4½ inches by 8 inches
Distance between centers of journals	75 inches
Diameter of wheel fit on axle	5⅜ inches
Diameter of center of axle	4¾ inches
Type of truck bolster	Channel iron
Type of truck transom	Channel iron
Length of tender frame over bumpers	20 feet 3½ inches
Length of tank	19 feet
Width of tank	9 feet 2 inches
Height of tank, not including collar	4 feet 8 inches
Height of tank over collar	5 feet 8 inches
Type of rear drawhead	Chicago coupler

LOCOMOTIVE ATTACHMENTS.

Wheel centers	American Steel Casting Co.
Tires	Midvale
Axles	S. L. W.
Sight-feed lubricators	Nathan latest improved
Bell ringer	Gollmar
Couplers	Chicago
Safety valve	Ashton
Sanding devices	Dean's
Injector	N. & Co. Monitor No. 9, Type "R" of 1897
Driver brake equipment	American
Tender brake equipment	Westinghouse
Tender brakebeam	Kewanee
Tender brakeshoe	Ross-Meehan
Air pump	Westinghouse, 9½ in.
Air pump governor	Westinghouse
Steam gauges	Ashcroft

The Limits of Steam Pressure in Locomotives.

BY G. R. HENDERSON.

The great increase in locomotive boiler pressures in the last 10 or 15 years has naturally led to the thought whether this increase would still continue, and where the limits will be found.

Fifteen years ago 125 pounds per square inch was considered a standard pressure, although a few roads were working up to 140 pounds and 150 pounds. Nowadays 200 pounds pressure is very commonly employed. While this has been brought about largely by trying to benefit especially the compound locomotive, yet it has also resulted in increasing the pressure for simple locomotives.

At present Continental Europe seems to be ahead in boiler pressure, in simple as well as compound engines. In this country and in Great Britain the maximum limit is 200 pounds, but the Saint Gotthard Railway is using 205 pounds on a compound locomotive, the Paris, Lyons & Mediterranean Railway 213 pounds on a simple engine, and at the Brussels Exposition this year the Belgian State Railway exhibited a compound locomotive operating with a gauge pressure of 220 pounds per square inch. We believe that these are the highest pressures used, up to this date, on locomotives. Some marine pressures have exceeded this, but the majority are thought not to run over 200 pounds.

The question therefore arises, what is the advantage of this greater pressure, and what are the difficulties to be overcome in operating it?

Some years ago a prominent railway of Great Britain made some tests to determine what pressure was the most economical in a certain passenger service, and it was commonly reported that the results showed that 160 pounds gave the greatest economy. Desiring to confirm this fact, we wrote to the locomotive superintendent (with whom we have the pleasure of an acquaintance) and his reply was entirely different from what was currently believed.

The engines used in making the comparative tests were of the following proportions:

Diameter of cylinders	18	inches
Stroke "	26	"
Driving wheels (4) diameter	78	"
Heating surface, tubes	1,090	square feet
" " firebox	112	"
" " total	1,202	"
Grate area "	19.5	"
Weight of engine	45	long tons
" tender	40	"

The results of the test are shown by the following table:

SUMMARY OF RESULTS OF HIGH STEAM PRESSURE TEST.

No. of Eng	Steam pressure	1st Section.				2d Section.				E
		A		B		A		B		
		C	D	C	D	C	D	C	D	
76	200	153	49.14	153	53.90	268	51.01	228	51.[illegible]4	....
77	175	138	50.63	138	56.94	259	52.25	217	46 20	10.94%
78	150	137	49.14	151	53.90	237	52.57	246	43.67	22.45%

A—Up journey. B—Down journey.
C—Weight of train in tons. D—Speed in miles per hour.
E—Excess of steam used per horse-power per hour as compared with 200 pounds pressure.

The trials were made in October and November, 1889.

These results, as far as they go, do not need any comment. The well-known formula for the efficiency of a heat engine $\frac{T_1 - T_2}{T_1}$ (in which T_1 is the absolute temperature of entering steam, and T_2 the absolute temperature of exhaust steam), indicates the advantage of high temperature steam. R. Clausius, in his "Mechanical Theory of Heat," says that "in order to get the greatest advantage from engines driven by heat, the most important point is to increase the temperature interval $T_1 - T_2$."

William Kent, in his "Mechanical Engineers' Pocket Book," page 747, shows the effect of working steam expansively, and as there is a minimum limit for the exhaust pressure, on account of retaining the proper action on the fire, this can be construed to explain the advantages of high pressure.

These are in a measure, however, offset by cylinder condensation, which has generally been considered as being dependent upon the ratio of expansion, and various tests of simple engines have indicated that a cut-off of from .2 to .3 of the stroke was the most economical.

Later experiments point to the belief that the actual expansion ratio has practically no influence on the amount of condensation per stroke (Kent, p. 753) but that the condensation depends upon the difference in temperature of the admission and the exhaust. This leads us at once to the advantage of the compound engine, in which this difference is much less in any one cylinder, and this applies, no matter whether the condensation depends upon the ratio of expansion or the variation in temperature solely.

If, in a simple locomotive, we assume that we should not have a higher terminal pressure than 25 pounds per square inch, a cut-off of .2 would call for an initial pressure of 185 pounds) by Mariotte's law) or say 200 pounds in the boiler. A higher terminal pressure or an increased expansion would not be economical, as seen above, the first on account of the high value of T, and the second on account of increased condensation. This would indicate that 200 pounds is about the economical limit of cylinder pressure for simple locomotives.

Compound locomotives enable us to reduce cylinder condensation by having less difference in temperature between the admission and exhaust. The ratio of the cylinders of compound locomotives varies from 2 to 3; 2.5 may perhaps be considered an average value. Seaton, in his "Manual of Marine Engineering," recommends an increased cylinder ratio with greater pressures, but this does not seem to be adhered to in locomotives. The most economical point of cut-off does not appear to be definitely fixed for compound locomotives, but it is probably between ⅓ and ½ stroke of the high-pressure cylinder. This would give a total expansion of 6, and if we desire a maximum terminal pressure of 25 pounds, as above, the limit of initial pressure would be 225 pounds, or say 240 pounds boiler pressure. Of course, these are not advanced as being the final limits which *boiler pressures* will reach in locomotives, but they are suggestions of what will probably be found to be desirable limits for cylinder pressures.

In an editorial of the November issue of the AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL there was a sugges-

tion as to the use of higher boiler pressures, with cylinder pressures about as indicated above. This proposition we consider perfectly possible and logical from an engineering standpoint.

There is no difficulty in making a boiler that will be safe for this or even higher pressures, but as we increase the strain the maintenance becomes more troublesome. Staybolts and flues promise to become restive, owing partly to the increase in expansion due to the higher temperature; and partly to the greater pressure directly. It is probably quite true that the greater amount of trouble experienced with flues now, to what it was a few years ago, is due largely to the high pressures carried.

Relief from these troubles may be found in other forms of fireboxes and boilers, and the water tube boiler, the Docteur brick-lined firebox, or the corrugated cylindrical firebox (like the Strong boiler) each and all promise to overcome some of the troubles mentioned. There is no doubt that some radical departure from the old lines of locomotive construction would be gladly received by progressive railroad officials.

There are other incidental difficulties, however, in the matter of cylinder and valve lubrication. A good cylinder oil should not flash below 525 degrees Fahr., or burn below 600 degrees, the lubricant being mineral oil with from 15 to 25 per cent. of animal oil mixed with it. The temperature of steam at 240 pounds pressure is about 400 degrees Fahr., and it is probable that a still heavier oil could be used with advantage.

The white metal in the metallic packing on piston rods and valve stems must also be considered. If it is proportioned so as to resist a high temperature without melting, the rings become so brittle that they will break in pieces in service; if made tougher the melting point is too low.

A few years ago, we undertook some tests, to determine what mixture was most desirable for metallic packing rings. The compositions experimented with were as follows:—

Mixture	1.	2.	3.	4.
Tin	87	90	93	93
Copper	8	7	6	3
Antimony	5	3	1	2
Lead	—	—	—	2

No. 1 was the mixture recommended by the United States Metallic Packing Company.

No. 2 was our own formula.

No. 3 was recommended by the Columbian Packing Company.

No. 4 was the result of an endeavor to get a tough, easily molded metal. It was found that while No. 1 had the highest melting point, viz., 448 degrees Fahr., yet it was so brittle that it stood no bending, but snapped off short.

No. 2 melted at 441 degrees, but was not so brittle.

No. 3 had a melting point of 432 degrees but this was quite flexible, a strip ¼-inch thick bending to a right angle before cracking.

No. 4 was tough, and ran easily in the mold, but the melting point was only 420 degrees Fahr.

Taking these different properties into consideration, we found that it was quite difficult to decide on the mixture which would be generally best to use. We might add at this point that it is quite important to use new metals only when making up the mixture for metallic packing rings.

In the above, we have merely attempted to outline what would be the probable limit of steam pressures in locomotives, and also some of the difficulties that may be encountered in reaching and using such pressures. These troubles will probably be overcome after further experimenting, and in the future pressures now considered uncommon may be controlled as easily as those now in use. Steam jackets may bring about a greater expansion ratio, with its increased economy, but any arrangement which adds to the complication of the locomotive is apt to be considered with much conservatism—in this country at least, and rightly so. With the longer runs and shorter time at terminals, simplicity of construction has economic features, as great, possibly, as a fair saving in fuel, and this factor cannot be ignored. Even the Corliss valve, so highly thought of, for stationary engines, while it has met with some favor in France, has been totally neglected in this country as far as locomotives are concerned. The same applies also to separate cut-off valves and in general simplicity of mechanism, and the reduction of parts to look after and keep in repair are thought to be among the most important principles in railroad engineering.

Labor and Our Railroads.

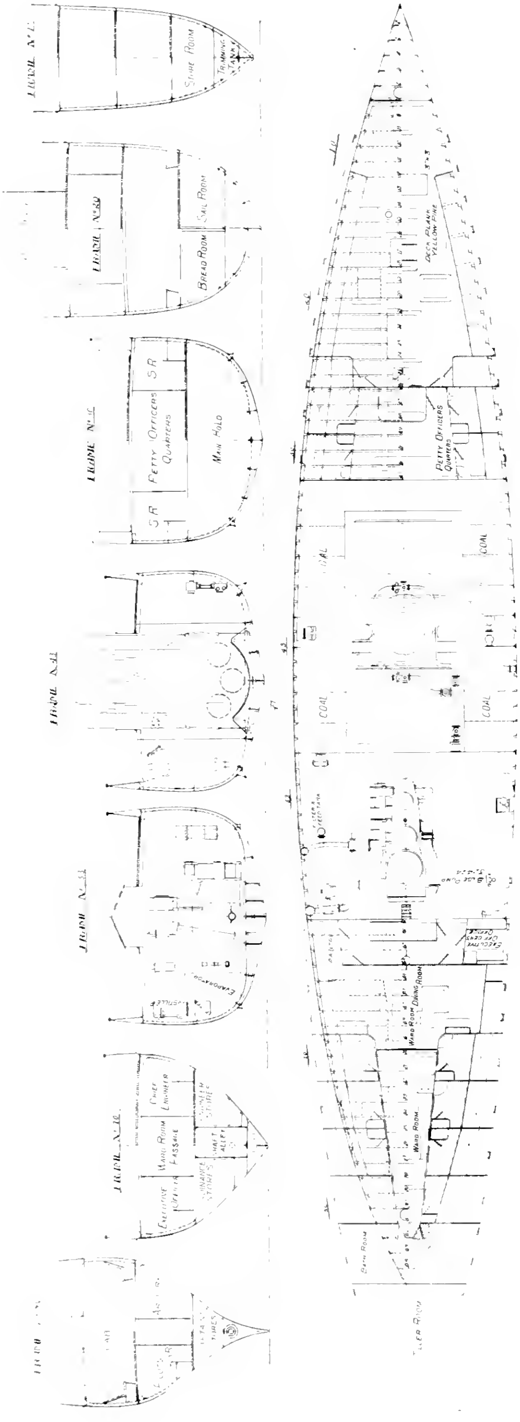
The report of the Interstate Commerce Commission just issued contains for the first time some facts in relation to the total amount of money paid out by our railroads in wages and salaries to labor. These figures, embracing 90 per cent. of all employees, show that for every $100 paid out as operating expenses of railways more than $60 is paid over directly to labor. Of the remaining $40 probably an equal, if not a greater, proportion is indirectly paid out for labor.

The interest of labor in the railway question is far greater than the interest of capital, and yet, for some unknown reason, says Robert P. Porter in the New York *Sun*, the defense of these properties has been left to capital, while labor has, until a comparatively recent time, taken little interest in the conflict. During a period of nearly 25 years there has been more or less national legislation and an infinite variety of State legislation in relation to railways, and yet during that whole period experts inform us that legislation has never been friendly, but always unfriendly, to railway interests. As a consequence of this, the capital originally invested in railways has lost its earning power, and for every $100 thus invested more than $70 has no earning power.

During this period there has been no reduction in the rates paid labor, but in one way labor has suffered and severely. The plight in which our railways have found themselves has not only actually reduced the number of wage earners employed, but, relatively to the increase of mileage, has prevented the employment of additional hands. On the basis of 200,000 miles of railways, we should employ at least five hands for each mile, giving direct employment to 1,000,000 persons. Instead of this, we had only 826,620 persons employed in 1896. Thus, while Populistic legislators are joyously dilating over the manner in which they have destroyed the earning powers of the railway monopolists, the heads of nearly 200,000 American families, representing nearly 1,000,000 men, women and children, have been seeking in vain for a job. On the other hand, had half the annual earnings, say at 5 per cent., of upward of $4,500,000,000 of stock and bonds now in default been applied to the pay of labor employed in the maintenance of these properties, as over 60 per cent. of them would have been, every one of these homes might have been prosperous and happy.

The facts show that two-thirds of the capital invested in railways is to-day earning nothing, without counting the 16 per cent. of bonds in default of interest. On an estimate of 200,000 idle men out of 1,000,000 our railways should employ, if prosperous, 20 per cent. of the labor is earning nothing. If the rates continue to decline and properties to deteriorate, labor, which, even under these adverse conditions, is receiving far more than capital, will come next, and reduction of wages, with all its attending horrors, must come, not as a matter of choice, but of necessity, because a greater share of the capital has already gone down under adverse legislation and the terrific competition which has continuously and unreasonably reduced the earning powers of so many of these great enterprises. In 1896 the official figures show that of the operating expenses alone the enormous sum of $468,824,531 was paid out in wages and salaries. This does not represent the sums indirectly paid for labor, but only those directly paid. Relatively to labor, dividends, interest, rentals and so forth, are comparatively small. The time has therefore come for the labor interests of the country, directly and indirectly dependent upon railways, and the immediate business interests all over this vast domain of ours, whose prosperity is equally dependent upon the success of these undertakings, to look over the situation and decide for themselves if it is not time to cry a halt on all legislation which has for its direct aim the further wrecking of interests so tremendously interwoven with the welfare of every class of labor.

The Union Pacific Railroad was sold to the reorganization committee Nov. 1, 1897. It was sold under a mortgage, which was held by the United States government, and the bid of the committee was $39,883,281 for the property itself and $13,645,250 for the bonds held in the sinking fund. In addition to these bonds, the sinking fund holds $4,033,400 in cash, which reverts to the government, and which makes the total amount paid the government $57,534,932. The purchasers have 90 days in which to pay the full amount of the purchase money in accordance with the terms of the sale.



United States Revenue Cutter No. 6.—Sections, Berth Deck and Hold.

United States Revenue Cutter No. 6.

Through the courtesy of Captain Russell Glover, Superintendent of Construction, and Captain John W. Collins, Engineer in Chief of the United States Revenue Cutter Service, we are enabled to present the accompanying engravings and description of the new revenue vessel which will soon be built for service on the Atlantic Coast with headquarters at New York City. The plans of the ship were prepared by Mr. James W. Lee, Naval Constructor of the Revenue Cutter Service, under the direction of Captain Glover. The outboard elevation shows the general appearance of the vessel, and it will be seen that she has poop and forecastle, beside the berth and main decks and that auxiliary sail power is provided, each mast being of a single stick 87 feet high. The length of the vessel over all will be 188 feet and between perpindiculars 170 feet. The breadth molded will be 29 feet and the depth from base line at side amidship 16 feet 6 inches. The displacement to mean draft of 10 feet amidship will be 706 tons which will be the cruising displacement. The successful bidders for the vessel were the Columbian Iron Works and Dry Dock Company, of Baltimore, Md., whose bid was $141,000.

The main engine will be of the vertical triple expansion type, having one high pressure cylinder 20¾ inches in diameter, one intermediate cylinder 32 inches in diameter and one low pressure cylinder 50 inches in diameter, the stroke being 27 inches. The total horse power will be 1,500. The main valves will be of the piston type for the high pressure and the double-ported slide type for the other two cylinders. The valve motion will be of the Stephenson link motion, with double bar links. The engine frame will consist of three front columns of cast iron and three short columns at the back cast on the main condenser. The crank line and propeller shafts will be of forged mild open-hearth steel and will be solid. The piston rods, connecting rods and other working parts will be of high tensile open-hearth steel.

The main condenser will have a cooling surface of 2,343 square feet, the water passing through the tubes; the air pump will be independent and the circulating pump will be of the ceutrifugal type.

There will be two single ended steel boilers of the horizontal return fire tube type constructed for 160 pounds pressure. The boilers will be placed in a water tight compartment by themselves, and will have one fire room. Each boiler has three corrugated furnaces of 3 feet 3 inches diameter, and the total heating surface will be 3,392 square feet, the grate area being 112 square feet. The outside diameter of the boilers will be 13 feet, and the length 10 feet over all. The forced draft will be furnished by one blower discharging into the fireroom. The ash ejector will be of the hydro-pneumatic type. Open hearth steel is required for the boilers, and each shell will be in one course of two plates $1\frac{3}{16}$ inch thick.

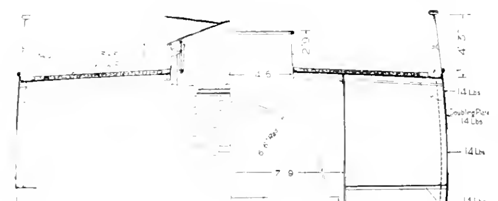
The engines will drive a single propeller of manganese bronze, with four blades, the diameter being 9 feet 4 inches. The thrust shaft will be 9 inches in diameter with nine thrust collars, and the intermediate shaft will also be 9 inches in diameter, and the propeller shaft will be 9½ inches.

A distilling apparatus with a capacity of 3,500 gallons will be placed in the engine room. The main steam pipe will be of copper and 7 inches in diameter.

There will be nine transverse water tight bulk-heads stiffened by 3 by 2-inch vertical angles spaced two feet apart. The transverse frames which are spaced two feet apart are of Z section 5 by 3¼ by 3¼ inches and weighing 11.6 pounds per foot. The upper flange of the Z will be cut off from the turn of the bilge to the lower end of the frame forming an angle bar 4 by 3 inches. The main frame bars are to be cut off against the lower angles of the vertical keel plate and the reverse bars are to butt against the vertical keel plate.

The vertical keel shown in the midship section will be 21¼ inches deep and of 15 pound plate. The flat keel plates are double and are worked in 18-foot lengths. The flat keelson plates will be 9 inches wide on each side of the vertical keel, and tapered at the ends of the vessel. The bilge keels extend a distance of about 110 feet amidships, and stand normal to the bilge; they are to be formed of 10-pound plates, riveted at the outer edges to a 2½ by ½ inch flat bar, while the inner edges are held to the plating by angles and tap rivets. The bilge keel plates will be filled in with yellow pine, as shown in the midship section.

The main deck beams are to be of angle bulb section, 6 by 3 inches, a beam being provided at every frame and the spring being 6 inches in a length of 29½ feet. The berth deck beams

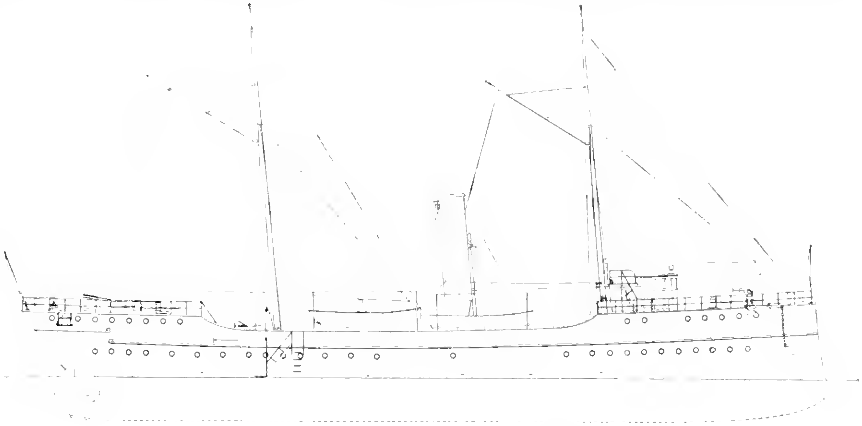


Midship Section.

will be of 3 by 2½-inch angles and straight. The forecastle and poop deck beams will be of 3½ by 2½-inch angles. The stanchions are to be tubular and of wrought iron.

There are to be three longitudinals on each side of the vessel, and continuous angles will be placed on the inner edges, while the lower edges will be flanged to the outside plating and all will be formed of intercostal plates. The outer plating is shown in the larger sectional view, the bulwarks and sides of forecastle and poop are to be of 10-pound plate. For a length of about 100 feet amidships, an additional sheer strake or doubling plate will be used and a similar method of strengthening will be used on the bow to a point 28 feet each side of the stem and 4 feet above and 4 feet below the water line. The stem will be of one piece of 7 by 2¾ inch iron rabeted to receive the plating. The stern frame is to be of wrought iron in three pieces.

The pilothouse and chartroom are the only projections above the forecastle deck. The roof of the charthouse will be extended to the sides to form a bridge. The quarters of the petty officers and men are under the forecastle deck. The steering engines are


United States Revenue Cutter No. 6.—Outboard Elevation.

under the pilothouse and it is not yet decided wheather steam or pneumatic gear will be used. The tiller ropes will be ¾-inch steel wire cables and will lead under the main deck beams, passing through brass pipes through the wardroom. The wardroom is at the after end of the berth deck, the bulkheads being of white pine. Each stateroom contains a berth, with drawers and lockers below, a small bookcase, portable desk, and a locker, all furnished in quartered oak. Parquetry flooring of oak will be used. The wardroom dining-room will be 11 feet long and the entire width of the vessel. The wardroom pantry adjoins the dining-room and on the opposite side of the vessel is the executive officer's office. The cabin stateroom, lavatory, office, pantry, passage and aft cabin are to be constructed of white pine panel work with festoons of composition for decorations, to be finished in white and gold. The floor is to be of oak parquetry with a neat border. The cabin will be finished in white and gold with white pine panel work and composition festoons. A small cabin will be fitted up at the extreme after end of the main deck and will have a seat running around the stem of the vessel upholstered in pebbled leather. The captain's office is at the forward end of the house on the starboard side and is to be fitted in a convenient manner.

The vessel will have two trimming tanks formed by the hull proper at the extreme forward and after ends. These will be filled and emptied by valves worked from the deck above. The steam heating and sanitary fitting and piping system will be very complete and the vessel ought to be a comfortable one. From a careful examination of the whole design including the machinery it appears to be admirably adapted to the purpose for which the vessel is intended.

American Electric Railroad Apparatus in England.

Electric tramway installations of a high grade of excellence can be bought, but, if we accept the testimony of experts, they cannot be bought in England, says the *Railway World*. Certainly they cannot be obtained here with the economy and the confidence that they can be bought in America. And so when important contracts for electrical tramway apparatus are to be made we have a hegira to New York, and a foregathering in palatial hotels of the representatives of American firms from the Atlantic to Chicago. A swift and sharp competition follows, and our tramway managers and contractors return thoroughly satisfied that they have saved their companies' money and at the same time have secured the best electrical apparatus that can be obtained. How large a share the Americans will play in developing the field here depends largely on their own enterprise. At present the advantage is with them. Their apparatus is unsurpassed. American manufacturers were shrewd enough to understand that it was the era of local transport and they stopped short of no possible efforts to put themselves in a position to meet and even to encourage every demand.

Communications.

Throttling vs. Expansion.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

I have read the discussion of the subject of throttling vs. short cut-offs in the November issue of your paper with much interest, and I think your treatment of it is excellent.

The whole question which you raise is really a very complex one, growing out of the fact that the locomotive is required to work under so wide a range of conditions. I think that cylinder condensation is not the only important factor which operates against the use of short cut-offs. Equally important it seems to me is the fact that the mechanism of a locomotive of ordinary proportions is hardly equal to the requirements of good service at short cut offs under a full throttle at high speeds with the high steam pressures now in use. An attempt to run an engine in this way so often results in hot pins and in defective steam distribution, due to spring and lost motion in valve mechanism, that the result on the whole is somewhat discouraging.

I say this not with the intention of detracting from the efforts of your argument, which, I take it, needs no reinforcement, but for the purpose of emphasizing another side of the question.

Nov. 3, 1897. MEMBER A. S. M. E.

[This communication was written by one of the highest authorities in the country upon the steam locomotive, and we are exceedingly glad to have his indorsement of the suggestion offered in our November issue. Our correspondent mentions a very important failing that is beginning to be appreciated when he refers to the defective steam distribution that is caused by the springing of valve gears. In our October number (page 356) an account of some tests containing large and small locomotive valves was given wherein this flexibility of valve gear was believed to explain some of the apparent advantages of small over large valves, and there is plenty of evidence to be had to convince anyone that a perfectly balanced valve is greatly to be desired. This suggests the great advantage possessed by piston valves with respect to the low frictional resistance, and we believe that the trouble which our correspondent mentions may be almost entirely overcome by using them.—EDITOR.]

Crank Axles.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

Referring to the communication on page 376 of your November issue, by Mr. Merrill Davis, we would say that we think there are many objectionable points in crank axles. They are quite expensive to manufacture and finish up, and certainly are much weaker than straight axles.

When at the Crewe shops of the London & North Western Railway, the writer was informed that all crank-axles, and particularly on passenger engines, were removed and scrapped after making a certain mileage, the amount of which has now been forgotten.

The arrangement of the valves and cylinders with such inside connected locomotives is generally very difficult to repair and inspect, and we think that all practical railroad men will agree that outside connected engines are preferable, in nearly every case, to those requiring inside crank axles.

G. R. HENDERSON.

NORFOLK & WESTERN RAILWAY,
Roanoke, Va., November 8, 1897.

Steam Motor Cars.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

The illustrated description of the steam motor car for the New England Railroad which you published last month interested me, and in view of the prominence given to the same subject in the editorial pages of that issue I am prompted to present some suggestions in the way of serious difficulties which I believe will be found in connection with the proposed system.

I think you are correct in believing the managers of the steam railroads to be at their wits' ends to know how to meet the electric railroad competition, but I think that the idea of using combination steam locomotives and cars for this purpose is not good railroading. It is very easy for an editor who sits at a desk to theorize over such questions, and he is very likely to overlook some practical objections involved in such a radical idea as this. I believe in your enthusiasm over a new idea you have not considered some very important sides of the plan the New England Railroad proposes and you endorse.

In the first place it will be impossible to operate such an outfit with two men. It will not be safe to load the care of an engine and boiler as well as the operation of the car upon one man, and I am surprised that you lend any influence to such an idea. Instead of less we ought to have more men at the head ends of our trains. It is plain that with these cars shuttling in and out among the regular traffic trains of the roads the necessity for watching signals and guarding against things going wrong generally will be increased, and one man will be entirely unable to meet the requirements. By your own statement this new scheme is expected to increase travel and that will not improve matters any, but will make them worse.

I can see another very serious obstacle in the fact that these cars must be turned around at the terminals and it requires a large turntable to turn a car with a wheel base as long as 57 feet. You do not consider the expense of putting in these tables or of maintaining and operating them. They may be operated by steam power, but if by hand, the train crews could not do the work and extra help would be needed. Even then the wages cost might be lower than at present, but not so much lower as you appear to expect, and the cost of the turntables would be extra expense, when saving money is what we are after.

I look more favorably upon a plan that would make use of the old engines which are too light for heavy business and for an example point to the Illinois Central method of handling the World's Fair passenger business out of Chicago for which I believe not a single new engine was bought.

When the old light engines are used up it will be time to build new ones. These ought by all means to be independent of the cars for the reason stated and because it will be impossible to prevent the heat, noise and smell of the locomotive from annoying passengers at the other end of the car.

I do not oppose the idea of light steam power, but I believe the plan outlined to be wrong, and I am surprised to find it advocated by a first-class railroad. T. A. WESTERVELT.

Nov. 3 1897.

[We thank our correspondent for this opportunity to emphasize some points which we have already touched upon in the description of the new steam motor car for the New England Railroad. The argument with regard to the use of old worn-out engines in what is likely to become one of the most important fields of passenger transportation is not sensible. The most convenient way to turn the motor cars around will be by the use of turntables. These are however, not essential to the success of the plan, because they may easily be turned on "Y" tracks, or in the manner that the large motor cars of the Twin City line, between Minneapolis and St. Paul, are turned. Those cars have but one set of controllers, and they are turned at each end of the runs by passing them around a city square. If, however, a turntable is necessary, no extra help is required to operate it if it is equipped with an electric motor in accordance with a plan that is outlined elsewhere in this issue. It has been demonstrated that on elevated railroads, where the interlocking signals are by no means few in number, one man is abundantly able to run the train in safety; and while it would appear that a steam locomotive would necessarily require a great deal of attention, we have reason to believe that this combination may be safely handled in this way. These motor cars will be run on the railroad right of way and not through the streets; the boiler will not require any attention between stations and the locomotive is as easy to operate as an electric motor. If necessary, it will be a comparatively easy matter to fit the boiler with an automatic stoker, which will dispose of the work of feeding the fire for an entire trip, and the water-level in this type of boiler may fluctuate enough without danger to effectually dispose of the question of the necessity of watchfulness in feeding the boiler. To separate the locomotive from the car will defeat the chief object of the plan. The combination idea is one of its most valuable features, because in no other way can the subdivision of train units be carried out as in electric railroad practice, and the most valuable lesson that steam railroad men have to learn from electric practice is the necessity of using small and frequent units in suburban service.—EDITOR.]

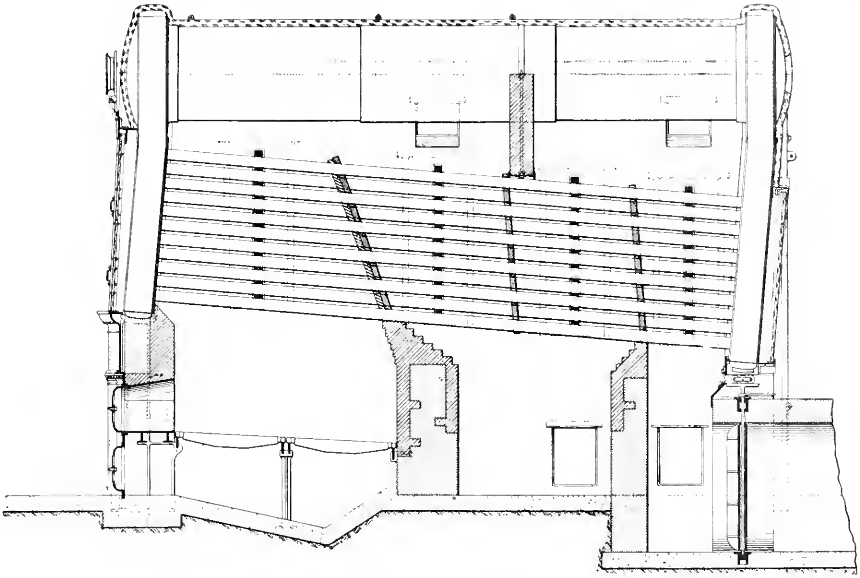
The Edge Moor Water Tube Boiler.

The experience of the Edge Moor Iron Company, of Edge Moor, Del., in the construction of steam boilers has been brought to bear in the production of a new boiler of the water tube type, which we are glad to describe and illustrate in the accompanying engravings, from which the new features will be readily understood.

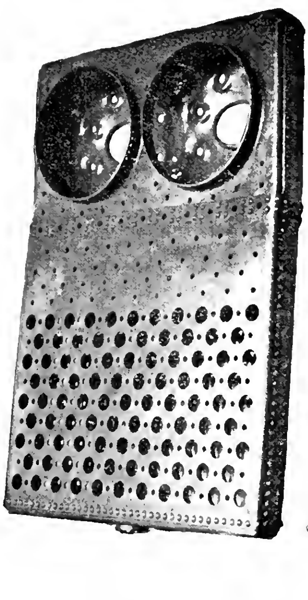
The boiler is constructed in four sections, consisting of drums, upper and lower headers and the tubes. The drums and headers are constructed entirely of flanged steel. The drums enter the headers at their full area, to which they are connected by flanges, avoiding the necessity of cutting the drums to make a connection for the headers, and creating a solid steam and water connection between all drums without the use of outside connections. The upper header is domed opposite each drum, thus avoiding large, flat surfaces.

The tubes are expanded into the inner side of the lower header, and opposite each tube a flanged oval hole is provided, faced and fitted like an ordinary manhole with oval cover and dog. The covers, being on the inside of the header, are tightened in position by the boiler pressure, and each cover is independently removable.

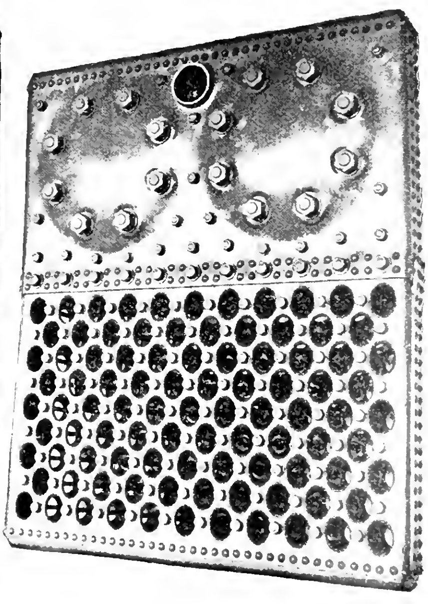
The flanging of the front plate of the lower header stiffens this plate and the joint surfaces rendering the joints easier to keep water tight and necessitating fewer stays, as this feature eliminates largely the extent of flat surface. The upper and lower headers are connected at an angle



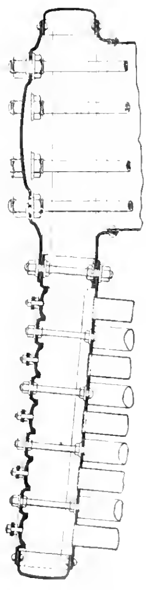
The Edge Moor Water Tube Boiler.



Inside View of Two Drum Back Header Showing Flanges for Shell Connection.



Front View of Two Drum Front Header.



Cross Section of Front Header

to give sufficient inclination to the tubes to insure a positive and rapid circulation.

Special attention is directed to the arrangement of the baffle plates, which is such that the gases are forced to surround every part of the tube heating surface and the lower side of the drums, and enabling the gases to reach the stack through an underground flue, obviating the necessity of a heated sheet-iron connection in the boiler-room. By means of the construction of the headers, and their connections to the drums, unusually large water areas are obtained for circulation, which reduces to a minimum the usual contraction of circulation through these parts, and avoids the unsteady water level generally experienced under forced firing.

The arrangement of the drums permits of obtaining a large liberating surface and storage capacity, as well as forming a solid water heating surface over the tubes, preventing loss by radiation, which cannot be altogether avoided where large spaces are necessary between the drums.

In general, while possessing to a great extent the best elements of water-tube types of boilers, it has large areas for circulation: the gases are carried in close contact with all the effective heating surface, and practically, even in the largest sizes, there is one drum with the water and steam space of two or more, thereby insuring a steady water line, unimpeded circulation, effective heating surface, dry steam, quick response to unusual demands, and simplicity of construction with perfect accessibility to all parts.

There are so many special features about each application of a boiler in practice that only a general consideration can be given in a brief description, and we believe that the builders will be glad to give further information.

Electric Motors for Driving Turntables.

The turning of locomotives and cars at division points and terminals is a source of much annoyance and no little expense to railroad companies. Workmen are not usually especially employed for this service, but engine wipers and helpers about the engine-house are called upon each time the turntable is used. The number of men that usually assist in this work is four, two at each end of the table, and the time they lose from their regular duty is considerable, as they are frequently in the pit under an engine, in the engine-house or on top of an engine or in some other inconvenient place when called and their movements are often slow because there is no incentive to hurry.

In our June issue, page 191, of the current volume a system for operating turntables by electric motors on the Chicago, Milwaukee & St. Paul Railway was illustrated and we are now informed that a somewhat similar plan has been worked out on the Baltimore & Ohio Southwestern Railway. The general master mechanic of that road estimates that it costs 12 cents to turn each engine by hand. Observing the delays and the expense attending them, one of the master mechanics about two and a half years ago worked out a plan for turning the 60-foot turntable at Chillicothe, O., by means of an electric motor. This motor was applied to an old car wheel by cast-iron spur gear wheels, so as to reduce the speed. The car wheel and motor were attached to a frame which was hinged to the gutter of the turntable, the car wheel to run on the circular rail or the track of the turntable. It was found that the weight of the frame, motor and car wheel was sufficient to give necessary adhesion so that the tractive force would easily turn any engine.

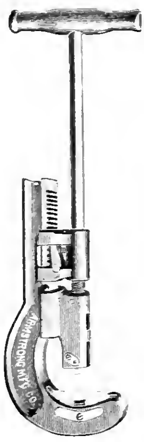
On trial it was found that the heaviest engine could be turned completely around in 56 seconds. The current is carried to the motor by an overhead wire which is connected directly over the center of the turntable by two brass rings insulated with hard wood so that a perfect contact is always obtained, thus furnishing a good conductor for the current to the motor. The current is controlled by a rheostat and switches, so that the motor may be run in either direction and at such speed as may be desired. This is done by a simple lever which is moved back and forth.

The cost complete, including the motor, did not exceed $500, and after two and a half years' use the device seems to be in excellent condition, and has given such good satisfaction that it was decided to operate the turntable at Park street, Cincinnati, O., in a similar manner, except that the current is taken under ground, and connection was made around the center cone of the table so that all wiring is concealed, thus presenting a neater appearance.

The electrical power is purchased from the Union Depot Company through a meter. The cost of this power for four months, viz., May, June, July and August, was $29. This turntable is used on an average of 50 times each day, thus making a cost of less than one-half cent for each time the table is turned, while if it was operated by hand, using the figures of the General Master Mechanic (12 cents for each engine), it would have cost $738, which shows a saving of $709, no allowance being made for repairs; the repairs, however, will never be very expensive.

A New Armstrong Pipe Cutter.

The engraving shows an improved form of the well-known No. 3 pipe cutter, manufactured by the Armstrong Manufacturing Company. This tool, it is claimed, is the strongest and most rapid working pipe cutter on the market, and it is also the cheapest: this by reason of its taking a larger range of pipe than any tool known that is made for a like purpose, viz., from 1½ inches to 4 inches, inclusive.



New No. 3 Armstrong Pipe Cutter.

The change from the smallest to the largest size is made by simply raising a pawl and allowing the hooked bar to slide outward. To change to a smaller size the hooked bar is pushed in to the required size, when it is ready to cut. The thread on the handle is only used to follow up the cut as the cutter is revolved about the pipe. This cutter may be changed from a three-wheel to a one-wheel cutter by simply substituting rollers in place of the two cutter wheels at the end of hooked bar.

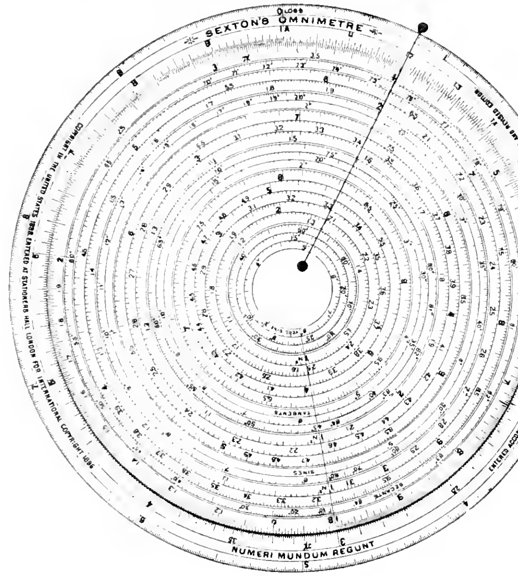
Full information will be furnished our readers upon application either to the home office of the Armstrong Manufacturing Company, at Bridgeport, Conn., or 139 Centre street, New York City.

Sexton's Omnimetre.

A convenient form of calculating instrument, similar in principle to the well-known slide rule, has been devised by Mr. Sexton, who is connected with the Southwark Foundry and Machine Company, and placed upon the market by Messrs. T. Alteneder & Sons, of Philadelphia. The new instrument is in the form of circular non-absorbent disks of bristol-board, secured concentrically upon a pivot fastening so that one may be revolved with relation to the other, and may be secured in any desired position by a thumb screw. The disks, as shown in the accompanying engraving, carry concentric circles accurately divided into parts which are proportional to the logarithmic values of the functions which they represent, and the principle upon which the instrument is arranged is that of the slide rule, namely, that the logarithm of the product of two numbers is equal to the sum of the logarithm of the numbers and the logarithm of the quotient of two numbers is equal to the difference of the logarithms of the numbers.

A number of functions are given on the instrument, among which are logarithms, numbers, squares, square roots, cubes and cube roots, fifth powers and root, sines, tangents, versed sines and secants. There are several forms of the omnimetre, and the most complete have all of these functions, while the less complete, sold at a lower price, have less of them.

The omnimetre which is before us is one of the most complete, the price of which is $3, while the other forms cost $2 and $1. The one with which we have experimented is a fine piece of work. The disks are very well made and printed and the instrument is provided with a transparent arm bearing a fine radial line for the purpose of assisting in the calculations. The one illustrated is set in such a way as to permit of the multiplication of a number by 3. It will be noticed that the numeral 1 on the "B" circle (see the oblique, nearly vertical line at the lower side of the engraving) is opposite the numeral 3 of the outer or "A"



Sexton's Omnimetre.

circle. To multiply 4 by 3 find 4 on the "B" circle and opposite it on the "A" circle is the answer 12. This is a very simple illustration, but it will serve to show the ease with which the instrument may be used. Though the processes make use of logarithms, no knowledge of logarithms is required in the use of the instrument. The omnimetre is copyrighted by Mr. Thaddeus Norris, of Philadelphia, who has devoted a great deal of careful attention to the arrangement and construction of the instrument, and as far as a few simple calculations can be convincing of its value the omnimeire appears to be very satisfactory. It is worthy of investigation.

The Railroad Problem.

At the three fall conventions of the New York Board of Trade and Transportation held during the month of October a number of valuable and interesting papers were read, among which was one upon The Extension of the Powers of the Interstate Commerce Commission by the Hon. Martin A. Knapp, Chairman of the Interstate Commerce Commission, which gives a clear and thoughtful review of the railway question and of the legislation, which is necessary alike for the permanent advantage of the public and the railways. In opening his address he makes clear the important distinction between injustice by rate-cutting and injustice in rate-making. The Commission, Mr. Knapp claims, is powerless to ferret out the various devices by which preferential rates are obtained and to punish railroad officials for failure to observe their published schedules. These, he contends, are discriminations between individuals, and should be placed in the catagory of misdemeanors. No amendment in the law by Congress in the direction of giving the Commission greater power in enforcing penal remedies for rate-cutting, he thinks, will meet the case, but the remedy may better be found in legislation which will remove the cause for this species of wrongdoing. In Mr. Knapp's opinion, it can best be stopped in this way:

How can rate cutting be stopped? The most efficient and available remedy for this evil, in my judgment, is legalized pooling. The carriers should be permitted and encouraged to contract with each other for the movement of competitive traffic, and thereby have it in their power to restrain and control the unseemly strife which inevitably results in fluctuating rates and vicious discriminations. The benefits supposed to result from railroad competition I believe to be greatly exaggerated. Those who uphold the present policy apparently assume that the public gets the same sort of advantage from competition between carriers as from competition between producers and dealers generally. That this is a mistaken and fallacious view I am fully persuaded. I do not see how anyone can derive benefit from competition in the matter of his daily wants, unless he is in a situation to choose freely between two or more persons who are each able to supply those wants. The objective value of competition rests in the power of selection, and he who is debarred from choice must be deprived of any direct advantage from the rivalry of others. As to most of our wants—broadly speaking—every person in every place has the opportunity to choose. And this liberty of selection is commonly enjoyed as to the ordinary needs of life, whether simple or complex. But in respect of railroad transportation only a few people comparatively are so situated as to have any available choice between carriers. So that, without amplifying the argument, the simple fact is that only a small percentage of population, and an exceedingly small fraction of territory, are so located as to have any practical opportunity for selection in the matter of public carriage. To the great majority of people railway transportation is now a virtual monopoly. The result is that a few commercial centers and a few large shippers, having this power of choice, and finding their traffic indispensable to the carriers, secure great advantages of which the masses are deprived. It is entirely plain to me, therefore, that co-operative methods, the general discontinuance of competition in rates between rival railroads, would tend strongly to remove the inequalities which now exist, and prove a positive and substantial advantage to the great majority of producers and consumers.

In advocating this plan of action, Mr. Knapp is advancing along the lines of the experience of railway management, not only in the United States, but in England and in all other countries where railways are not under State control. Such a course of action would undoubtedly secure that uniformity and stability of rates which all right-minded men desire. Mr. Knapp takes the ground that carriers should be allowed to combine their facilities to the end that wasteful warfare between them may be prevented and the economies of association applied to the business of public transportation. The Interstate Commerce Commission distinctly sets forth that such combination would in no way increase rates to the public, because it would be within the province of Congress to clothe the Commission with proper authority to enforce just and reasonable rates. Fair and workable laws, he says, should be enacted to protect the public interests against exorbitant rates and when there are secured, the public have no particular interest in the manner in which the business is divided between the several competing roads. The first question is of vital interest to the public, the second of little importance.

Our contemporary the *Railroad Car Journal* is likely to work itself into a state of nervous prostration, or something else, over an alleged abduction of the Master Car Builders' Association by the Master Mechanics' Association. Who are the men in charge of the car departments, anyway?

(Established 1832.)

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

28TH YEAR. 66TH YEAR.

PUBLISHED MONTHLY BY R. M. VAN ARSDALE, MORSE BUILDING..........NEW YORK

G. M. BASFORD, Editor.

DECEMBER, 1897.

Subscription.—$2.00 *a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union.*

Subscriptions for this paper will be received and copies kept for sale by the Post Office News Co., 217 Dearborn Street, Chicago, Ill.

EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Special Notice.—*As the* AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL *is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 25th day of each month.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* **When a subscriber changes his address** *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

The paper may be obtained and subscriptions for it sent to the following agencies: **Chicago,** *Post Office News Co., 217 Dearborn Street.* **London, Eng.,** *Sampson Low, Marston & Co., Limited St. Dunstan's House, Fetter Lane, E. C.*

An automatic signal application on the normally danger plan using semaphore signals and switch indicators and providing protection to trains by means of home and distant and advance signals at stations is the longest step in advance taken by railroad signaling in years, and we would direct special attention to the interesting description of the new work on the Illinois Central Railroad by Mr. W. J. Gillingham on another page of this issue.

The painting of cars by means of compressed-air spraying machines has been looked upon very conservatively by many car builders. They sometimes raise the objections of wastefulness of paint, inferiority of work and danger to the men from inhaling the fumes from the spray. The important improvements in railroad work often have some slight objectionable features at first and in many cases these disappear as a result of experience. It is believed that the merits of air spray painting are likely to survive criticisms and to place this process among the valuable improvements of recent times in car work. The ruling question in this case is that of cost, and Mr. H. G. MacMasters in a paper which is presented in part in this issue shows the saving to be 64 per cent. in painting a new box car over that of hand work, and the saving in truck work is even greater. In this comparison the cost of brushes and the paint lost in the spraying is not considered, but the saving in labor is large enough to overbalance a considerable loss of paint. There has been trouble in some cases with the uneven drying of the sprayed paint, but this has been found to be remediable by careful mixing of the paint and by using the proper amount of japan and linseed oil as a reducer. We are informed in a communication by Mr. MacMasters, that he uses less paint when applied by the jet than when put on by the brush, and this disposes of the statement that the jet scatters so much paint that it is wasteful. He has repeatedly taken weights and measurements to compare it with brush work. To those who are still doubtful of the advisability of spraying careful consideration of the paper referred to is recommended.

Our English contemporary, *The Railway Magazine*, does us the honor to notice the paragraph in our October issue, commenting on the complexity of signals on English railroads and very courteously intimates that we would not have so many railroad wrecks if we did our signaling as thoroughly as the English do. Now thoroughness in signaling is absolutely necessary to safety, and we would be the last to slight its great importance, but we think our contemporary misunderstood us a little. We are among the greatest admirers and supporters of correct signaling, but we do not believe in using one more light or blade than is absolutely necessary to the safety of trains, and we repeat that the great number of signals used in English plants constitutes an argument for simple signaling.

The comparatively large number of recent elevator accidents directs attention to the character of the automatic clutch devices which are intended to prevent the falling of elevators when the gearing of the hoisting ropes breaks. In spite of the fact that good engineering talent is concerned in this branch of transportation there seems to be an opportunity to offer a suggestion to the effect that it is not safe to rely upon the action of an automatic device which does not operate frequently. One of the fundamental principles in railroad signaling requires a failure of the apparatus or sticking of the parts to give a danger indication, which directs attention at once to the apparatus and compels investigation. This ought to be brought into elevator practice in such a way as to render it impossible to use the elevator if the safety devices are not in working order. It is unquestionably easier to make this suggestion than to apply it, but this is believed to be the direction in which the safety devices of the future should be sought.

The trouble caused by the destruction of the records of any department of a railroad company is a calamity which must be experienced in order to be appreciated. A fire in the general office building of one of the Western roads recently consumed the entire office records of several departments, including that of the Chief Engineer, whose maps and plans had been prepared at great expense of money and effort. These may all be replaced, but records of the right of way, deeds and surveys cannot be replaced without going over the work from the beginning. It would cost less to provide a fireproof vault for such valuable property, and it is a matter for wonder that such precautions are not always taken. It is not unusual to find the tracings, drawings and valuable papers which have accumulated for years in the conduct of railroad business stored in frame buildings where, perhaps from thoughtlessness, perhaps for the sake of economy and immediate convenience, they are not protected in any way against loss by fire. This applies to mechanical as well as to other departments and such an example as the one mentioned ought to call attention to the true character of such so-called economy. Insurance cannot cover the loss of this kind of property and the best preventive is the provision of adequate vaults. They may usually be constructed without great expense. The road referred to may be depended upon to furnish an example of one that will be thoroughly equipped against such losses in future.

The Anti-Scalping Movement.

War to the death seems to be the programme in regard to the iniquitous incubus, ticket scalping, and it is time that this nefarious business was absolutely done away with. It would not have lived so long if it had not had some strong support and as the props are one by one taken away the structure is rapidly falling. It seems as if the business would soon have no leg to stand on. The roads are and have been ready to redeem tickets which are not used, and in some sections even the much vaunted support of the organizations of traveling men has been lost to the scalpers. Pronounced action has been taken by them in the interests of legislation against scalping and in assisting in carrying out the laws. We have the lowest rates in the world and have also the very best service in the world, and why the passenger business of the country should so long have been allowed to be the feeding ground of a multitude of vampires is not easy to explain. With the influence of the Interstate Commerce Commission and the legislatures of 10 states as well as that of the Dominion of Canada all working in the same direction it is safe to predict that the death so long awaited is near at hand. The friends of anti-scalping laws and their enforcement owe much to the energy and persistency of Mr. George H. Daniels whose tireless efforts in the crusade have done much to make this type of thievery disreputable.

The chief patronage of the scalpers has come from commercial travelers, and the most encouraging action yet taken is that of the National Association of Merchants and Travelers, in which the organization is on record in positive terms urging Congress to pass the anti-scalping bill without delay. They say: "Ticket scalping is a burden from which the transportation companies ought to be relieved, in common fairness, and also the citizen who travels infrequently and is not posted as to rates of fare and the methods of the scalper, should be protected from fraud in the purchase of tickets which will not be honored for passage, and from the inducement to lying and forgery, as against public morals."

THE PASSING OF THE WOODEN FREIGHT CAR.

Freight car construction in this country is now in a positive transition stage, owing to the rapid approach of the steel car age. In trucks, it may be said that wooden transoms have almost entirely disappeard, though there are some few roads whose car superintendents are so benighted as to use them on new cars. During the past year the wooden truck bolster has been the exception, and the majority of new cars have metal truck bolsters, either of cast-steel, pressed steel or of the various forms built up from angles, tees, channels and plates, and some malleable cast-iron truck bolsters have been placed in service. Large numbers of pressed steel trucks are now made, and at least half a dozen companies are extensively engaged in building metal freight trucks.

In the change from the wooden bolster to the metal one, a decided modification has been made in truck design, which places the springs inside the arch bars, suspending them from the cross channels. This method admits of a much shorter bolster, the length being reduced from over 7 to 5 feet, and the distance between supports from 6 feet 3 inches to 4 feet. A much lighter bolster can be obtained by this improvement. A composite bolster 5 feet long and 8 inches deep with two ½ by 8 inch plates sandwiched between oak planks, weighs complete with center plate and side bearings about 400 pounds. When made of cast-steel, the weight is 280 pounds; of malleable iron, 300 pounds and of pressed steel 320 to 365 pounds. As far as trucks are concerned, it may be said that current practice is to build them entirely of iron and steel.

As we approach the car body, the first thing above the truck, the body bolster is found to be rapidly changing from wood to iron. It is true that iron body bolsters made of ¾ by 6, or 1 by 7 inch rolled bars, have been used for years, but they were so badly designed that they would not carry the load of even 40,000 pounds without excessive deflection and bending, thus throwing too much of the weight on the side bearings. Some roads have rejected this form and substituted steel eye beams, while others have developed the bar iron bolster into a good design, making it of much greater depth and width, and using malleable iron for the filling pieces; but neither the eye beams nor improved bar iron body bolsters can long hold a place, when compared with the ideal designs in pressed steel, by the Schoen Pressed Steel Company and the Bettendorf bolster by the Cloud Steel Truck Company. The bolsters designed by these companies appear to be almost perfect in the disposition of the metal to secure extreme lightness with sufficient strength. Body bolsters built up of bar iron for 60,000-pound cars weigh as much as 780 pounds each, while those of pressed steel for the same capacity have been made as light as 500 pounds in one design and 350 pounds in another. It is possible that economy of material has been carried too far in some of these designs, and the metal is so thin in some parts that we doubt if it will resist corrosion and shock combined much over 10 or 12 years. This branch of car building is developing so rapidly and railroad methods are changing so radically that it may not be necessary to provide for over 12 or 15 years' service. At the end of that period 60,000-pound cars may be as obsolete as 30,000-pound cars are now, and it may be desirable to replace them with equipment of much greater capacity.

The upper framing of a box car of 40,000 pounds capacity is not very different from that of a 60,000-pound car. The upper work is principally for the protection of the lading, and is not intended to assist in carrying the load. With this understanding of the case, many roads have found it an easy matter to change cars of small capacity to those having 50 per cent. greater capacity by putting in good body bolsters and deep truss rods. The center sills of freight cars are the most vulnerable part of the underframing. It is an old standing rule of the Master Car Builders' Association that center sills must not be spliced, while other sills may be. The draft and buffing resistance is almost entirely on the center sills. For this reason they have received first attention when any improvement upon wooden sills has been attempted.

Wooden draft timbers have always been the source of most frequent failures, and the cause of most repairs on wooden cars, and a better foundation for the draft rigging has long been desired. This fact has naturally led to the design of wooden cars with steel center sills, to which the draft gear is securely fastened. Such a design with 10-inch channels weighing 25 pounds per foot has been worked out, and some few cars built from it, but an extra cost of about $20 per car has prevented a more extended use of it.

Steel end posts for box cars have been extensively used by one or two roads for a number of years; and box and stock cars with upper and under framing of steel were built by the Harvey Steel Car Company previous to 1893. Many of them are still in service, but as they cost more than wooden cars, and the capacity was not increased, their only advantage is a longer life and less cost for repairs, items which railroad managers have not found sufficient reasons for increased cost of new equipment.

Malleable castings are rapidly coming into general use on freight cars, resulting in a reduction of 40 per cent. as compared with the weight of cast-iron formerly used. The common grey castings used on a box car weigh about 3,500 pounds and the reduction in weight by the use of malleable iron is 1,400 pounds. It is found that sections ¼ and ⅜ inch thick in malleable iron are sufficient for most car castings which were formerly made ½ or ⅝ inch thick. The advantages of malleable iron are now so thoroughly realized that one or two car companies have found it necessary to build malleable iron foundries, and others will doubtless follow. The same is true of some foundry companies supplying grey iron castings to railroads for repairs.

Coming now to the weight and carrying capacity of wooden cars, we find in it the principal reason why they cannot be used economically, when a greater capacity than 60,000 pounds is desired. Freight cars of this capacity will be most economical for local merchandise for many years to come, for, as the country becomes more thickly settled, this kind of traffic grows larger.

For short hauls and cars only partly loaded, large capacity and corresponding dead weight are neither desirable nor economical. For long distance grain haul, a car of larger capacity will be found economical and it will probably be built with a steel underframe and wood upper structure. For coal and ore 80,000 and 100,000-pound capacity steel cars will rapidly come into use. A steel car weighing 28,000 pounds will carry 80,000 pounds and one weighing 34,000 pounds will carry 100,000 pounds. Compare these weights with wooden cars of high capacity. The Chicago & Eastern Illinois Railroad has recently put into service a number of 80,000-pound capacity coal cars built with wooden sills and coal sides and they weigh 32,500 pounds, or 7,500 pounds more than a steel car of equal capacity. A coal car built by the Fort Wayne road for 70,000 pounds capacity weighs 35,000 pounds, the dead weight being just one-half the paying load, and 10,000 pounds more than a steel car having 10,000 pounds greater capacity. A coal car of 100,000 pounds capacity, with steel underframe and wooden box, has been built for the Erie Railroad by the Michigan Peninsular Car Company. The weight of this car is 40,000 pounds. The Schoen steel car, of similar capacity, weighs 34,100 pounds, a difference of 6,000 pounds in favor of the all-steel car. Tabulating the above to show the ratio of light weight to carrying capacity we have the following for coal and ore cars:

Material.	Capacity.	Light Weight.	Ratio of light weight to carrying capacity.
Wood	60,000 pounds.	25,000	41.6 per cent.
Wood	70,000 "	35,000	50 " "
Wood	80,000 "	32,500	40 " "
Steel	80,000 "	28,000	35 " "
Steel underframe	100,000 "	40,000	40 " "
Steel	100,000 "	34,000	34 " "

The above figures show plainly why the wooden car for coal and ore must go, and it is passing rapidly. We see no reason why steel underframes will not replace wood for large capacity grain cars.

We have thus described the passing of the wooden car, and in a future article will take up the advantages of steel cars more in detail.

EFFECT OF BRAKEBEAM HANGING ON BRAKE EFFICIENCY.

It is regretted that space is not available to publish in full the paper presented by Mr. R. A. Parke on the Effect of Brakebeam Hanging on Brake Efficiency, recently read before the New York Railroad Club.

Mr. Parke first raised the question of the advisability of using a braking power of 70 per cent. of the weight of cars in freight equipment, and 90 per cent. in passenger equipment; brake power being the ratio between the aggregate pressure of the brakeshoes upon the wheels and the weight of the car upon the wheels. Pressures of 70 per cent. of the weight of the cars are commonly used in freight service, while 90 per cent. is commonly employed in passenger service. The power on freight equipment ought to be increased in order to render more to it available when the cars are loaded. The ratio is, of course, lower when loaded than when empty, and the consideration of these questions emphasizes the importance of improving the conditions, particularly of freight brakes, and every one must admit the value of any improvement in the means for increasing the ratio on passenger cars. The paper showed that even with the present pressures there is more tendency to slide the wheels of freight cars than those of passenger cars, in spite of the much greater brake power of the latter equipment. This was due to several causes, among which was the fact that the shorter length of the freight cars permitted inertia to act in a way to tend to tip the car forward in stopping so as to cause the pressure to be much greater on the front wheels than on the rear ones of each truck.

The amount of this transfer is not known, but it is perfectly clear that some transfer does take place, as may be seen by watching a truck of a passenger car just as it is coming to a stop at a station. The reason for the transfer is that the adhesion of the rail acts as a retarding force when the brakes are applied, and as this retarding force is applied at the lowest point on the wheels a tendency to tip about the center of gravity occurs, which causes the transfer of weight. This tipping of the trucks throws some of the weight that ordinarily is carried on the rear wheels to the front wheels, and relieving the weight on the rear wheels tends to make them slide more easily and reduces the braking power to that dependent upon the weight that remains upon the wheels that carry the lightest load. It is necessary to use less pressure on the rear wheels as long as equal pressures are used on all the wheels in order that the pressure may not be too great for the rear wheels and cause them to slide.

The purpose of the paper may be stated to be to provide a plan whereby the brakeshoe pressure may be proportioned to the actual pressure of each of the wheels upon the rails. It was incidentally intended to provide means whereby the tendency for the car and the truck to tip during the stop might be reduced. It is evident that a solution of these problems would render it possible to greatly increase the efficiency of the brakes.

The solution found may be briefly stated to be the use of inside hung brakebeams and of hangers inclined away from the wheels, the tendency of which is to decrease the pressure of the brake shoes on the rear wheels and increase the pressure of the shoes on the front wheels. The sketches of trucks fitted with beams hung in this way, presented in the abstract of the paper, will make the reason plain, and will show the effect of the brake hangers in carrying components of the thrust of the brakeshoes to the truck frame, the reactions of which bring about the increase of pressure on the shoes of the front axle and decrease the pressure on the shoes on the rear axle. It is also evident that these reactions in the hangers will tend to a certain extent to correct the tendency for the trucks to tipped by inertia. It should be noted that reversing the motion of the train reverses the conditions and the hanging that is correct for one direction is equally correct for the other.

The possible effect of the hangers to exaggerate the tilting of the trucks may be seen in a passenger truck when the brakes are outside hung. In this case the forward hanger pulls the front end of the truck frame down and the rear hangers tend to push the rear end up. From this it will easily be seen that the inside hanging will reverse these thrusts.

The advantages offered by these suggestions by Mr. Parke are the following: The release springs become unnecessary because the brakebeams will of their own weight tend to fall away from the wheels; the efficiency of the brakes will be increased in the emergency applications from 10 to 15 per cent. without danger of sliding the wheels; the distance in which a passenger train, going at a rate of 60 miles per hour, can be stopped, will be decreased by about 200 or 250 feet; and these improvements may all be had without any increase of the expense of building or maintaining equipment.

We would like to dwell upon many of the very interesting points mentioned by the author of the paper, but cannot do so here, and must content ourselves with this brief summary. If these paragraphs induce our readers to study the paper itself our purpose will be carried out. We believe it to be the most important contribution to the literature of the air brake since the publication of the results of the Burlington brake tests.

NOTES.

The conversion of old consolidation locomotives into eight-wheel switching engines is practised at the Mt. Clare shops of the Baltimore & Ohio. The pilots are removed, the front ends of the frames are cut off and the front truck is eliminated.

The Chicago & Northwestern is making extensive additions to its block system and now has it in use between Boone and Clinton, Ia. Block signals are now in use between Chicago and Minneapolis, and very soon the road will have it in operation on 800 miles of its line. The blocks average four miles in length and the system is operated by the station operators, like that of the Chicago, Milwaukee & St. Paul Railway.

In tearing up a siding on the Straitsville division of the Baltimore & Ohio Railroad recently the section men discovered that

several of the rails had been made in 1863. Subsequent investigation revealed the fact that these rails were part of a lot that were bought in England during the war at a cost of $125 per ton in gold. The rails were still in very fair condition and for light motive power would last ten years longer.

The average fare per passenger for the busy hours on the Metropolitan Traction Company's lines in New York City is shown by President H. H. Vreeland in a paper read at the Street Railway Convention to be but 2½ cents. This is for the hours when crowds are going and coming to and from their work and the low rate is due to the large numbers of transfers. One out of three passengers is transferred and a ride of 25 miles may be had for one five cent fare.

Much gratification is expressed at the War Department over the report received of a test at Sandy Hook of the new Crozier-Buffington 12-inch disappearing gun carriage. The test was for rapidity alone, as the carriage had successfully passed other requirements. No carriage of that size had been tested before, and there was some doubt as to its utility. Ten rounds were fired in 16 minutes and 57 seconds under adverse conditions. A high wind and a beating rain interfered with the test, and in addition the gunners were not familiar with the workings of the new carriage.

The new Heilman electric locomotive was tested Nov. 12, before a great gathering of European railway men. The trial trip was from Paris to Nantes, over the Western Railway. The train hauled by the locomotive weighed about 200 tons. The trial was intended chiefly to illustrate the reduction of vibration and the regularity of movement of the new machine. This was demonstrated, but the speed did not exceed eighteen miles an hour. The directors of the railway company are reported to be pleased with the success of the locomotive, and it is stated that they have decided to adopt it. We doubt the adoption or the satisfaction.

The engine columns of new battleships have been made of nickel steel and according to a recent report by Chief Engineer E. R. Freeman, U. S. N., the nickel steel was preferred on account of its toughness, in spite of the fact that the tests showed high carbon steel used in similar columns to have somewhat better physical characteristics than the nickel steel. A severe cold bending test told in favor of the nickel steel, although the elongation and reduction of area were in favor of the high carbon steel. The nickel steel columns tested were all accepted, while some of the others were not because of defects which the annealing failed to overcome.

The use of wood in the construction of German naval vessels is restricted as far as possible owing to the experience of the battle of the Yalu. Herr A. Dietrich, quoted in the *Proceedings* of the United States Naval Institute, says that in the new German ships wood is used only in a few minor parts. The decks and ceilings are of metal, protected by linoleum or cork where necessary. The chart houses and captain's rooms on the bridges are all of steel, and aside from the furniture of the officers' quarters and the shelving in the ammunition rooms there is very little wood about the ships. Signal masts and flag poles are of steel, and wood is not used for hand rails. The object is to increase the fighting capacity by rendering the ships less likely to burn, reducing the dangers of flying splinters and reducing the weight of the ship so that more weight may be put into ordnance and armor.

The practice adopted by the French navy for the preservation of boilers not in use is different from that generally in vogue, and it is worth at least making a note of. They seem to take the bull by the horns. Instead of emptying the boiler, they fill it completely full of fresh water, and then add to the water a certain amount of milk of lime or soda. The solution used is not so strong for boilers with small tubes; it is intended to be just sufficient to neutralize any acidity of the water. Particular attention is given to the outsides of the tubes, if they are not to be used for a long time. They are painted with red lead or coal tar as far as they are accessible, and for the rest a protective coating is obtained by burning tar, the smoke of which will form a coating of soot. Besides this, the boiler casing is closed and kept air-tight, after some quicklime has been placed inside.—*American Machinist.*

A combination of the alternating and direct current systems for electric light and power circuits for large cities is advocated by Louis A. Ferguson in a paper before the Association of Edison Illuminating Companies. The advantages to be derived are the saving of two-thirds of the cost of fuel and more than that proportion of the cost of labor by removing the steam plants from sub-stations. A large central station plant, with alternating current distribution and transformers at the sub-stations, is advocated as a much better plan than that now in general use. The labor charge at the central station need not be increased, and by this method of distribution the most satisfactory means for providing for a fluctuating load-line may be found. The Edison Electric Illuminating Company of Brooklyn has adopted this method of distribution for the development of outlying territory, and is now installing apparatus on a large scale.

The case of the engineers in the navy, to which we have given so much attention, is in the hands of a board consisting of the following officers: Capt. W. T. Sampson, Commander of the battleship *Iowa*; Capt. A. S. Crowninshield, Chief of the Bureau of Navigation; Capt. Robley D. Evans, of the Lighthouse Board. Capt. Alexander H. McCormick, Commander Joseph N. Hemphill, Lieut.-Commander Richard Wainwright and Lieut. Albert L. Key, representing the line. Engineer-in-Chief George W. Melville, Chief Engineer Charles W. Rae, of the *Iowa*; Chief Engineer George H. Kearny, and Past Assistant Engineer Walter M. McFarland are the staff representatives. This board, with Assistant Secretary Roosevelt as its president, came to an agreement Nov. 8, which, when perfected, is to be put into the form of a bill and presented to Congress with the endorsement of the Secretary of the Navy. This action is understood to be along the lines of a plan reviewed in a recent editorial in this journal.

A novel proposition was made not long ago to the Receivers of the Baltimore and Ohio Railroad. This road has a branch running from what is known as Alexandria Junction, near Washington, to Shepherd's on the Potomac River, where a car ferry is operated in connection with the lines leading south from the capital. A professor of an eastern college desired to lease this short stretch of track for the purpose of educating young men in practical railroad work. In his letter he explained that he thought there was a wide field for bright and energetic boys who could be thoroughly well grounded in the practical side of railroading provided they could be educated on a regular line of road. He believed that by the employment of veteran railroad men as teachers that the boys could profitably spend two or three years working as trainmen, firemen, engineers, switchmen, station agents, and in other capacities required in the railroad service. As this branch is of considerable value, the Receivers were compelled to decline the offer.

Improvements on the Monon have been completed, the result of which is a material increase in the weight of trains which may be hauled over the road. These improvements consisted of the elimination of curves and the adjustment of grades at three places, the most important work being at Cedar Lake, Ind. Here five curves were rectified, one of one degree, three of two degrees and one of three degrees having been replaced by tangents and one one-degree curve, also a curve of five degrees and thirty minutes was reduced to three degrees. Instead of a series of grades ranging up to 1.66 feet to the 100 feet in each direction, the profile has been converted into a practically uniform grade in one direction with a maximum of .47 in 100 feet, or 25 feet per mile. One dip formerly having grades of 1 foot in 100 in one direction and 0.6 in the other is entirely removed and replaced by a grade of 0.09 per 100 feet, or 4.75 feet per mile. By these changes, which were planned by Mr. Ferd Hall, Chief Engineer

of the road, an increase of the possible weights of trains of from 29 to 40 cars per train has been obtained.

The largest power plant in the world will be erected by the Metropolitan Street Railway Company of New York for the purpose of furnishing power for the 218 miles of its street railroads. The plant will comprise 11 cross-compound condensing engines of 6,600 horse-power each and 87 water tube boilers of 800 horse-power each. Storage capacity for 9,000 tons of coal will be provided, the coal being stored in the upper story of the power-house so that it may be delivered to the boilers by gravity. The current from the power-house at 6,000 volts will be carried to sub-stations where static and rotary transformers will convert it to 550 volt currents for the conduits. The total horse-power of the plant will be over 70,000, which is far in excess of that of any steam plant now in existence. This will be a most interesting example of power distribution from a central station and much is expected from the consolidation of the power units of the four present stations into one. The cable system will be replaced by electricity and the underground trolley will be used for the whole of the system.

Rumors of pretty nearly every possible and impossible calamity that could influence the prices of stocks to decline were circulated the first week in November and among them was one to the effect that our country was soon to be invaded by the armies of Spain and we suspect the authorship of the following bogus dispatch which appeared in the New York *Sun* may be traced to a waggish broker who enjoys the acquaintance of Mr. George H. Daniels, General Passenger Agent of the New York Central. "Washington Special.—It is understood that Señor De Lome has telegraphed to New York for a time table of the New York Central & Lake Shore railroads, as he wishes to know which will be the most convenient train for the Spanish Army to take from New York to Chicago. It is understood that the New York Central officials, with a spirit of patriotism which other roads will do well to follow, have refused to send the time table. This will necessitate the Spanish Army going to Chicago via the Erie Canal. If cold weather sets in within the next few weeks, the canal will be frozen, and the Spanish Army prevented from reaching Chicago. This should have a good effect on the Granger stocks."

The improvements on the main line of the Baltimore & Ohio, west of and between Martinsburg, W. Va., and North Mountain, were completed November 1. They cover a distance of nearly four miles, starting three miles west of Martinsburg, and extending some distance west of Myers Hole, which is near the North Mountain station. At Myers Hole the line was changed, taking out some very objectionable curvature, and the roadbed was raised nearly 15 feet, eliminating two grades of 42 feet per mile, which came together at Myers Hole and substituting therefor an almost level track. This point on the road has always been a dangerous one and many freight wrecks have occurred there. Apart from doing away with the dangerous feature of two sharp down grades coming together, as was the case in this instance, the saving in operation of the road by the change will be very large, as it enables the tons per train to be greatly increased and reduces the liability to accident to the minimum. At Tablers, the roadbed has been lowered about 13 feet, and the same at Tabbs, besides taking out objectionable curvature and reducing the rate of grades at these points from 42 feet per mile to 10 feet per mile, thus increasing the number of tons that can be hauled per train. Though these improvements have cost quite a sum of money, the expenditure is fully justified by the great saving in the cost of operation.

Old windmill gearing was the subject of a note recently presented by Mr. C. W. Hunt to the American Society of Mechanical Engineers. The gearing usually consists of a face wheel of about 10 feet pitch diameter, into which a small lantern wheel about 23 inches in diameter meshes. Mr. Hunt said: In 1889 I visited a windmill in Holland with gearing similar to the Nantucket mill, which had been built 60 years before. The face wheel teeth were being renewed, and the owner informed me that the first set of teeth were replaced 30 years ago, and as these teeth had been in service 30 years he was again renewing them, evidently considering the "life" of gear teeth as 30 years. They were also renewing the main shaft, which had been in since the mill was built. The mill was used for grinding grain, and ran day and night, probably 18 to 20 hours per day for the entire time. The gear teeth were greased with tallow. The small wear of the teeth in service where the working pressure must be quite large for wood surfaces may be accounted for by their elasticity. The teeth of the face wheel, and especially the long rundles of the lantern wheel, are decidedly elastic, and when the pressure of the teeth is great they spring enough from the geometric lines to prevent all sliding of the surfaces in contact during the time that the pressure is great. The sliding of the surfaces takes place only at the beginning and ending of the tooth action, when the pressure is comparatively light.

The annual report of the General Superintendent of the railway mail service shows that at the close of the year there were 1,164 railroad postoffice lines, manned by 6,854 clerks; 33 electric and cable lines, with 102 clerks; 42 steamboat lines, with 57 clerks; making total number of lines 1,239, and total number of clerks 7,013. In addition to these there were 311 clerks assigned to duty at important junctions and depots, and 238 detailed to clerical duty in the various offices of the service, making a grand total of 7,562 clerks. The miles of railroad covered by railway postoffice car service was 154,225; of electric and cable, 303; and of steamboat lines, 7,459. The grand total of miles traveled of all classes of service was 282,830,031. There were 654 whole cars in use and 173 in reserve, and 2,026 apartments in cars in use and 540 in reserve. The number of pieces of all classes of mail matter distributed on the cars during the year was 11,571,540,680 exclusive of registered matter and city mail. Of registered matter there were 16,256,663 pieces in all. The amount of city mail distributed for stations and carriers during the year aggregated 462,469,640 pieces. The increase of ordinary mail handled over the previous year was 3.7 per cent. A comparative table covering a period of 10 years shows that there has been an increase in amount of mail handled of 77.2 per cent. and an increase in the working force of 48.6 per cent.

The provision of car sheds for housing passenger cars was strongly urged by Mr. J. A. Gohen, of the C., C., C. & St. Louis Railway, in a recent paper before the St. Louis Railway Club. Among the advantages urged in their favor was the protection of the equipment from the weather, and in discussing the subject Mr. G. W. Rhodes suggested that there was no need of the fine finish put upon the outside of cars, and that it would be better to provide them with such finish as would withstand the weather without the necessity of housing. There was no more reason for giving a piano finish to the outside of cars than for treating houses in the same way. This may make car painters squirm, but the suggestion is based upon good business principles. In this connection it is interesting to note to what extremes the matter of piano finish is carried on English cars. The *Railway Magazine* (England) states that the famous chocolate and white cars of the London & Northwestern receive no less than 16 coats, distinguished as follows:

Three coats of "white priming" (white lead, linseed oil and turpentine).

Four coats of "filling up."

One coat of red staining. This shows any surface inequalities, and the whole has to be rubbed down with pumice stone and water until not a particle of red remains.

The other coats are distributed as follows:

PANELS—WHITE.

Three coats of lead.
One coat of Kremnitz white.
One coat of enamel.
Three coats of varnish.

BODY—CHOCOLATE.

Two coats of lead.
One coat of brown.
One coat of lake (carmine, a very expensive color).
One coat of enamel.
Three coats of varnish.

Personals.

Mr. C. J. Snook has been appointed General Manager of the Texarkana & Fort Smith.

Mr. Edwin L. Moser, Mechanical Engineer, Philadelphia & Reading, at Reading, Pa., for the past six years, has resigned.

Mr. F. J. Ferry, Master Mechanic of the Louisville, Henderson & St. Louis, died at Cloverport, Ky., Nov. 4, at the age of 52 years.

Mr. A. A. Patterson, Jr., President of the Milwaukee, Benton Harbor & Columbus, has also been chosen President of the South Haven & Eastern.

Mr. Henry W. Gays, General Manager of the Chicago, Peoria & St. Louis, has been appointed General Manager of the St. Louis Chicago & St. Paul also.

Mr. A. S. Bosworth has been appointed Purchasing Agent of the Maine Central, with office at Portland, Me., and the office of Supply Agent is abolished.

Mr. W. J. Miller has been appointed Master Mechanic of the Southern Division of the Kansas City, Pittsburg & Gulf, with headquarters at Shreveport, La.

Mr. Joseph Billingham, Master Mechanic of the Baltimore & Ohio at Garrett, Ind., has been appointed Master Mechanic of the Pittsburg Division at Glenwood, Pa.

Mr. Samuel Thomas has been elected Vice-President of the Charleston & Western Carolina, with headquartere at Augusta, Ga., to succeed Mr. W. A. C Ewen, resigned.

Mr. R. C. Fraser, late of Fraser &Bailey. railroad supplies, has just been appointed Eastern representative of the Schoen Brake-shoe Company, with offices at present in Boston.

Mr. T. L. Dunn has been appointed Chief Engineer of the Maine Central, with office at Portland, Me., and will have charge of all matters relating to maintenance of way, bridges and buildings.

Mr. J. G. Livingston has resigned as Purchasing Agent of the Lexington & Eastern to accept the position of General Superintendent of the Interoceanic Railroad of Honduras, Central America.

Mr. W. J. Craig, heretofore General Freight and Passenger Agent of the Charleston & Western Carolina, has been appointed General Manager of the same road, with headquarters at Augusta, Ga.

Mr. W. White, Jr., Assistant General Foreman of the Pennsylvania shops at Wellsville, O., has been appointed General Foreman of the Illinois Central shops at Freeport, Ill. He takes the new position Dec. 1.

Mr. C. F. McDermott, General Foreman of the Baltimore & Ohio shops at South Chicago, Ill., has been appointed Master Mechanic of that road at Garrett, Ind., to succeed Mr. Joseph Billingham, transferred.

Charles W. Reiff, Traveling Passenger Agent of the New York Philadelphia & Norfolk, died at his home in Philadelphia from typhoid fever Nov. 9. Mr. Reiff was 39 years old and had been in the service of the company for nearly 20 years.

Mr. C. B. McCall has resigned as General Manager of the Litchfield, Carrollton & Western, and the office has been abolished. Mr. T. W. Geer, formerly Trainmaster, has been appointed General Superintendent, with headquarters at Carlinville, Ill.

Mr. M. F. Bonzano, General Agent for the Receiver of the Columbus, Sandusky & Hocking, has been appointed Superintendent and Chief Engineer of that road, with office at Columbus, O., and the position of General Agent for the Receiver has been abolished.

Mr. J. B. Braden, formerly Assistant Superintendent of Motive Power and cars of the Wheeling & Lake Erie, has been appointed Superintendent of Motive Power and Cars of that road, with headquarters at Norwalk, O., to succeed O. P. Dunbar, deceased.

Mr. J. E. Galbraith, who has been appointed Traffic Manager of the Cleveland Terminal and Valley Railroad Company, with headquarters at Cleveland, will also be the General Agent of the Baltimore & Ohio at that point. These two positions were formerly held by Mr. L. Rush Brockenbrough, who is now General Freight Agent of the Baltimore & Ohio lines west of the Ohio River, with headquarters at Pittsburg.

Mr. George W. Ristine, Receiver and General Manager of the Colorado Midland, was on Oct. 26 chosen President of the reorganized company, which took charge of the property Nov. 1. Mr. Ristine was appointed Receiver of the road May 1, 1895, and for three years previous to that date was General Manager of the United States Car Company at Chicago. He was formerly General Manager of the Erie Dispatch.

Mr. E. W. Grieves has resigned as Superintendent of Car Department of the Baltimore & Ohio to engage in other business, and the office has been abolished. The duties will be assumed by Mr. Harvey Middleton, General Superintendent of Motive Power. Mr. Grieves has been with the B. & O. since 1884 as Master Car Builder and Superintendent of Car Department, and was formerly for 16 years with the Harlan & Hollingsworth Company, of Wilmington, Del., as Chief Draughtsman and Foreman.

Mr. Oliver P. Dunbar, Superintendent of Motive Power and Cars of the Wheeling & Lake Erie, died suddenly at Norwalk, O., Oct. 30, of apoplexy. He was born at Hartland, Vt., Jan. 9, 1835, and had been in railway service since Oct. 24, 1854. His first work was as fireman on the Cleveland & Toledo, and after that he was, until September, 1859, Machinist and Locomotive Engineer on the same road. He served six months as Locomotive Engineer on the New Orleans & Jackson. For 15 years he served in the same capacity on the Cleveland & Toledo and the Lake Shore roads. In July, 1875, he was appointed Master Mechanic of the Canada Southern and remained in that position until Feb. 1, 1883, when he became General Master Mechanic of the Wheeling & Lake Erie. He was appointed Superintendent of Motive Power and Cars of the same road last April.

Thomas Doane, C. E., who built the famous Hoosac Tunnel, and had charge of many other important engineering works, died at Townsend, Vt., Oct. 23, at the age of 76 years. He was born at Orleans, Mass., in 1821, and was educated at the Andover Academy. After graduating, he entered the office of Samuel M. Felton, of Charlestown, Mass. From 1847 until 1849 he was resident engineer of the Cheshire Railroad at Walpole, N. H. In December, 1849, he returned to Charlestown and opened an office, where he carried on his profession of civil engineering and surveying. In 1863 he was appointed Chief Engineer of the Hoosac Tunnel. He located the line of the tunnel and built the dam in the Deerfield River to furnish water power. In 1869 he went to Nebraska, where he built 240 miles of the extension of the Chicago, Burlington & Quincy. In 1873 he was reappointed Consulting Engineer of the Hoosac Tunnel, and on Feb, 9, 1875, upon the opening of the tunnel, he ran the first locomotive through it. In 1879 he was appointed consulting and acting chief engineer of the Northern Pacific for one year, and since the expiration of that time he has been located at Charlestown, Mass.

Books Received.

A Field Manual for Railroad Engineers. By J. C. Nagle, M. A., M. C. E., Professor of Civil Engineering in the Agricultural and Mechanical College of Texas. First edition, 12mo, morocco flap. New York, 1897: John Wiley & Sons. Price, $3.

This book is intended for field use, and in order to render reference to its information easy a uniform notation has been adopted. Greek letters have been avoided except in a few cases, and a single letter has been used to indicate an angle. The figures have been

made self-explanatory as far as this could be done, and the necessary explanations have been reduced to a minimum. The arrangement of algebraic equations by which each has a distinct line permits of reading them easily. The author assumed a knowledge o fgeometry and trigonometry on the part of the reader and used higher branches only in the derivation of a few formulas for transition curves. The book was intended for use in the class-room as well as in the field. The following is the arrangement of the chapters:

Chapter I. gives briefly the general method of making Reconnoissance; Chapter II. treats of Preliminary Surveys; while Chapter III relates to Location.

Chapter IV., on Transition-curves, follows the method adopted by Professor Crandall, and enables one to locate the transition-curve with rigid accuracy where such is necessary. Approximate methods are also given by means of which the curve may be as easily located as any of the more limited easement curves ordinarily met with.

Chapter V., on Frogs and Switches, contains all that is necessary for their location. The formulas have been arranged to give the desired quantities in terms of the frog number whenever the resulting equations would be easier of application than the trigonometric ones usually given. The turnout tables are unusually full and give not only the theoretical lead but the stub lead as well, from which the practical lead can be at once found when the length of switch-rail is known.

Chapter VI., on Construction, tells how to set slope-stakes, and gives simple methods for computing areas and volumes either directly or by use of tables. A short table of prismoidal corrections is given for end sections level, and also a formula for three-level sections, by means of which a suitable table may be computed if desired.

The tables at the end of the book have been arranged with a view to ease of reference. A table gives the functions of a one-degree curve, other tables give the logarithmic and the natural functions The degree curve is defined with reference to a unit chord shorter than 100 feet for curves of over seven degrees and the curve tables are made to agree with this definition. Tables of co-ordinates of transition curves and deflection angles. In the tables vertical lines have been omitted wherever practicable, which renders it easier to consult them. All the trigonometric tables are given to five places, and the others were carried out to as many places as their character demanded. A number of convenient tables are given at the end of the work such as slopes for topography, rise per mile of various grades, material required for one mile of track and conversion tables for metric and English measures. It is a convenient book and is an improvement upon others which have been brought out for similar purposes.

The Imperial University Calendar, 1896-97. Imperial University of Japan, Tokio. Published by the University, 1897.

The Engineering Magazine, published by Mr. John R. Dunlap, has inaugurated a European edition published simultaneously with the American edition. The scope of the magazine is not to be limited by either national or geographical boundaries, but, as the prospectus puts it: "The world is its field and to make the world's best engineering practice available everywhere is its central purpose." Ten special articles and the engineering index will appear simultaneously in both editions. The editorial department of the foreign edition will be in charge of the following engineers: Civil Engineering, Mr. H. Graham Harris; Electrical Engineering, Mr. James Swinburne; Mechanical Engineering, Mr. W. Wonby Beaumont, and Mining and Metallurgy, Mr. David A. Louis. These departments will contain comments upon topics of current interest, and will be conducted after the manner of the corresponding departments of the American edition. Messrs. Charles B. Going and H. H. Supplee are the editors of the American edition. We wish our contemporary success in the new enterprise.

Trade Publications.

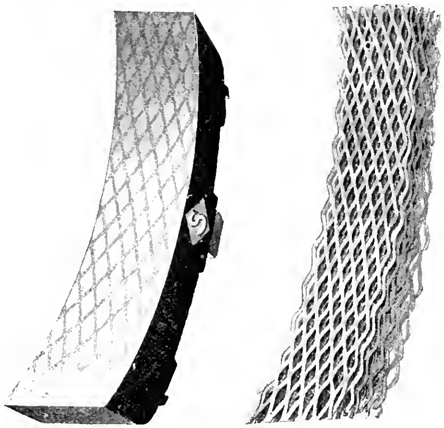
The Composite Brakeshoe Company has issued a 16-page pamphlet containing testimonials from railroad officers in New England having used the composite brakeshoes. The names of prominent roads outside of New England using these shoes exclusively might have been added, but the list includes only what may be termed home roads. Among them are many electric lines.

Bryant Sawing Machines.—The Q & C Company, of Chicago, present a general idea of the different sizes and capacities of their cold sawing machines in an illustrated standard size (9 by 12 inches) pamphlet of 24 pages. Sixteen different sizes and styles of machines are shown, and information is given with regard to saw blades. There are two long lists of users of this machinery, which include many well-known railroads and manufacturing concerns.

Sixty Minutes Between Philadelphia and Atlantic City is the title of a neat folder recently issued by the Philadelphia & Reading for the purpose of stating facts and figures regarding the fast train which ran between Philadelphia and Atlantic City last summer. An engraving gives a reproduction of a photograph of the train, and the folder gives in concise language an account of the train, details of weight and information about the cars and the locomotive, as well as a detailed record of the time made by the train during July and August. Those who desire to preserve this information in convenient form will be glad to send for a copy of the folder. Mr. Edson J. Weeks is the General Passenger Agent of the company, with office at Philadelphia.

Friction Tests of "Diamond S" Brakeshoes.

Our illustrations show the construction of the new "Diamond S" brakeshoes recently placed upon the market by the Sargent Company. The engravings show the construction to be a body of cast-iron surrounding a bundle of strips of expanded metal, cut to the proper shape and placed in the mold before the pouring. The result is a solid casting with a network of soft steel, running from end to end. One of the illustrations shows the bundle of expanded metal, another shows a cross-section through the shoe exposing the ends of the meshes and the third gives a view of the wearing



The "Diamond S" Brakeshoe and Steel Strips.

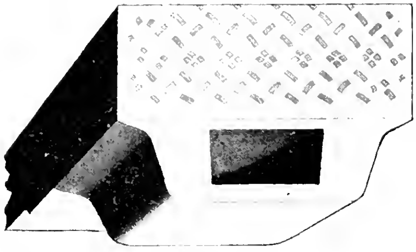
surface of the shoe, in which the cast iron is divided into diamonds by the expanded metal.

An excellent and uniform quality of soft steel is required by the expanding process and as the cast-iron brakeshoe mixtures used by this company are from a standard formula every precaution is taken to insure uniformity in the wearing surfaces, and this idea is carried out in the new shoe to a greater extent than before. It is evident that uniform breaking forces are not to be obtained without uniformity in the surfaces and with a combination of a truly quick action brake with a tight-holding brakeshoe good results in power breaking may be expected.

One effect of this construction is to present a constantly changing wearing surface. The wearing away of the shoe presents a change in the lateral position of the steel-rubbing surfaces, an effect never before produced. In the operation of this shoe the soft steel portions restrain the particles of east iron, preventing them from being removed by the wheel until the steel barriers are slightly worn down, whereupon the particles are carried on to the next diamond; this results in increased friction and increased durability, not before expected from a combination consisting so largely of cast iron. The shoe under consideration is the result of long study and of an effort to secure a combination of steel and soft cast iron minutely subdivided for the purpose of securing the maximum

friction effect, a coefficient of friction as nearly as possible half way betweeu those of soft cast iron and soft steel being desired.

It is not necessary to dwell upon the advantages to be gained by improving the efficiency of air brakes. It is enough to say that any method of shortening the distance in which a train may be stopped will be welcomed, and the recent Garrison's accident may



Etched Section Through Shoe.

be cited as an instance of splendid work done by the quick-action brake, and had it not been for this brake the results of the accident would have been frightful beyond expression. There is every reason for encouraging efforts to improve in these directions and for this reason and also because of their general interest, we herewith present extracts from some interesting tests upon these brakeshoes recently made by Mr. J. C. Whitridge on the laboratory brakeshoe apparatus of the Master Car Builders' Associotion at Wilmerding. These results were received just as we were going to press, which preveuts us from commenting upon them as we would like to do, but as the work was done and the results are tabulated as in the tests for the association, comparisons may easily be made. The report contains a detailed descriptiou of the apparatus employed, which we omit because our readers are already familiar with it.

The results of these tests together with service record show the new shoe to be greatly superior to the plain cast iron shoe in endurance. It has also been demonstrated that it will not harm steel tires. The greater endurance which equals that of hard shoes, which have long life at the expense of friction, seems to be due chiefly to the interference introduced by the soft steel fibers to the grinding away of the cast iron; the toughness and ductility of the soft steel disposed in this way holds up the friction while preventing wear. The report of the tests speaks for the superior friction effects of the new shoes.

FRICTION TESTS.

Outline of Tests.—The direct object in making the tests was first to determine, under several sets of conditions, the co-efficients of friction of "Diamond S" brakeshoes cast from both soft and hard iron; second, to obtain results under similar conditions for soft and hard plain iron shoes cast at the same time and from the same metal as the "Diamond S" brakeshoes; third, to have the conditions of initial speed, braking pressure and methods of conducting the tests the same as those used in the Master Car Builders' Association tests, made and reported upon in June, 1896. In this way the results of the present test can not only be fairly compared one with another, but also a comparison can be made directly with the results of the M. C. B. laboratory tests, where various brakeshoes were tried.

Such tests were made as would for all practical purposes, and without extending the work unnecessarily, show the relation which the friction of the "Diamond S" brakeshoes bear to the friction of other brakeshoes, under conditions previously selected by the M. C. B. Committee as representing passenger and freight service.

SCHEDULE OF TESTS—BOTH STEEL-TIRED AND CHILLED WHEELS.

Soft and Hard "Diamond S" Brakeshoes.

Speed, miles per hour.	Braking pressure, pounds.		
65	10,733	6,750	2,798
40	......	6,750	2,798

Soft and Hard Plain Cast iron Brakeshoes.

40	......	6,750	2,798

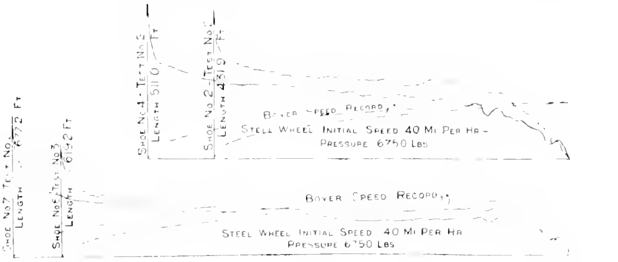
The braking pressure, 10,733 pounds, represents heavy passenger service, the pressure 2,798 pounds ordinary freight service, while the pressure 6,750 pounds corresponds to medium passenger service.

Brakeshoes.—The brakeshoes furnished for these experiments were of the usual form, to fit the M. C. B. standard head, $13\frac{3}{4}$ inches in length by $3\frac{1}{2}$ inches wide. The face of each shoe was turned or ground to fit the test wheels which are without taper and approximately 33 inches in diameter. The shoes were numbered from one to eight, as follows:

Shoe No. 1 and No. 2, soft "Diamond S."
" No. 3 and No. 4, plain soft cast iron.
" No. 5 and No. 6, hard "Diamond S."
" No. 7 and No. 8, plain hard cast iron.

It is believed that shoes Nos. 1 to 4, inclusive, are of approximately the same hardness as the "B" shoes of the M. C. B. tests; also, that the "A" shoes of the M. C. B. tests are of a much softer quality of cast iron than is generally used in service under the name of soft cast-iron brakeshoes.

Wheels.—The wheels used in the tests were, one chilled iron wheel, and oue steel-tired wheel with spoked center, being same oues used in the M. C. B. tests. The circumference of the chilled



Figs. 1 and 2.

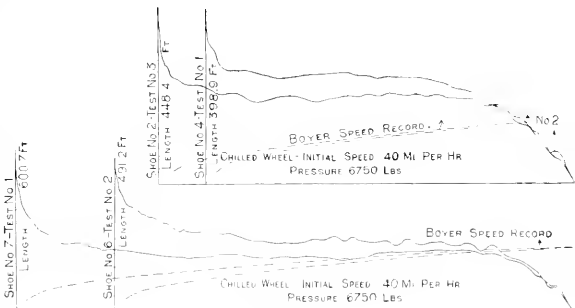
wheel is 103.5 inches while that of the steel-tired wheel is 103.3 inches.

Experiments.—The testing machine has not been used since the last tests made by the M. C. B Association, and no changes in the apparatus have been made. The same precautions were taken in making the present tests, and the same methods followed, which were used in former work done on this machine.

A comparison of the tests made on steel-tired and chilled wheels shows that the difference between the average mean co-efficients of friction obtained with the same shoe upon the two wheels are slightly higher in the case of the chilled wheel, excepting shoe No. 2 at 40 miles per hour initial speed and 2,798 pounds braking pressure, where the higher average was got on the steel wheel. It would appear, therefore, that practically the same results could be expected, as far as friction is concerned, from steel-tired and chilled wheels, with shoes similar to those tested.

A comparison of the co-efficients of friction given by the soft and hard "Diamond S" brakeshoes (Nos. 2 and 6) shows generally greater friction for the soft shoe, being most apparent at the heavy pressure tests from an initial speed of 65 miles per hour and throughout all of the tests at 40 miles per hour. The results with the two shoes at 2,798 pounds braking pressure and initial speed of 65 miles per hour are practically the same.

Comparing the hard "Diamond S" shoe, No. 6, and the plain hard cast iron shoe No. 7, in all tests, the shoe with the inserted steel gave higher mean co-efficient of friction. Tests on the steel-tired



Figs. 3 and 4.

wheel with the soft "Diamond S" shoe No. 2 gave higher mean coefficients than the plain soft cast iron; on the chilled wheel at 2,789 pounds braking pressure and 40 miles per hour initial speed, the results obtained with the two shoes were practically the same, but at the same speed and 6,750 pounds braking pressure the plain soft iron gave higher mean co-efficients.

The steel appears to increase somewhat the frictional qualities of very hard cast-iron brakeshoes, but where soft cast iron is so used the addition of the steel pieces does not greatly affect the friction; the friction in the case of the soft metal being practically the same for both the plain and the "Diamoud S" shoes.

Figs. 1 to 4 inclusive are sample diagrams of individuals tests which are nearest to the average for their respective groups. The cards from the "Diamond S" and the corresponding plain shoes have been traced so as to have a datum line line and starting point in common. The records given by the Boyer speed recorder are also reproduced. The following are the conditions represented by these cards:

Fig. 1.—Steel-tired wheel; initial speed, 40 miles per hour; braking pressure, 6,750 pounds; shoes No. 2 and No. 4.

Fig. 2.—Steel-tired wheel; initial speed, 40 miles per hour; braking pressure, 6,750 pounds; shoes No. 6 and No. 7.

Fig. 3.—Chilled wheel; initial speed, 40 miles per hour; braking pressure, 6,750 pounds; shoes No. 2 and No. 4.
Fig. 4 —Chilled wheel; initial speed, 50 miles per hour; braking pressure, 6,750 pounds; shoes No. 6 and No. 7.

TABLE OF RESULTS NO. 1.—TESTS OF 13-INCH BRAKESHOES ON STEEL-TIRED WHEEL.

	Shoe No.	Pressure on shoe, pounds.	Initial speed, miles per hour.	Travel of wheel, feet.	Mean pull on shoe, pounds.	Mean C. of F., per cent.	C. of F. near beginning, per cent.	C. of F. 15 feet from end, per cent.
Average, 3 tests	No. 2	10733	65.19	1330.2	1250.2	11.65	13.15	20.01
" 5 tests........	2	6750	65 37	1666.1	920 6	13.63	16.50	23.07
" 3 tests........	2	6750	40.46	437.8	1366.6	20.25	23 08	27.61
" 7 tests........	2	2798	65 22	3226.0	449 9	16.08	19.34	31.19
" 3 tests........	2	2798	40.46	758.3	711.1	25.41	26 66	31.10
" 3 tests........	4	6750	40 46	504 4	1218.9	18.06	17.22	26.99
" 4 tests........	4	2798	40 80	913.9	655.7	23.43	21.38	35.62
" 3 tests........	6	10733	65 64	1863.1	804 3	7.49	8 11	15.51
" 3 tests........	6	6750	65 19	1728.5	866.3	12.83	12 96	22.77
" 3 tests........	6	6750	40 91	597.4	892 7	13.23	12.96	22.06
" 3 tests........	6	2798	65 19	2751 6	468.9	16.76	16.25	30.26
" 3 tests........	6	2798	40 46	965 6	481 5	17 21	15.01	29.26
" 4 tests........	7	6750	40.46	665.8	827.1	12.14	11.56	22.55
" 3 tests........	7	2798	40 61	1076.8	440.9	5.76	13.89	30.38

Summary.—The principal results of these tests can be summarized into the following general statements:

The mean co-efficients of friction obtained from hard and soft "Diamond S" brakeshoes appear to be in the majority of tests slightly greater for chilled than for steel-tired wheels, but the differences are so small that the friction of these shoes can be regarded as practically the same for both kinds of wheels.

In general, the soft "Diamond S" brakeshoes tested give higher mean co-efficients of friction than "Diamond S" shoes of hard cast iron.

TABLE OF RESULTS NO. 2.—TEST OF 13-INCH BRAKESHOES ON CHILLED WHEEL.

	Shoe No.	Pressure on shoe, pounds.	Initial speed, miles per hour.	Travel of wheel, feet.	Mean pull on shoe, pounds.	Mean C. of F., per cent.	C. of F. near beginning, per cent.	C. of F. 15 feet from end, per cent.
Average, 3 tests	No. 2	10733	65.04	1294.1	1336.3	12.44	11.99	22 63
" 3 tests........	2	6750	65 19	1613.3	1086 3	16.09	17.33	28 68
" 3 tests........	2	6750	40.76	441.0	1408 6	20.87	23.08	30.17
" 3 tests........	2	2798	65 64	2964 8	504 6	18.03	23.07	36 95
" 3 tests........	2	2798	40.76	871.3	673.7	24.08	27.28	33.24
" 3 tests........	4	6750	41.06	409.9	1560.7	23.12	25.34	31.77
" 3 tests........	4	2798	41.06	880 1	700 4	25.04	21.70	39 69
" 3 tests........	6	10733	65.19	1527.5	1067 9	99.95	9.30	19.82
" 4 tests........	6	6750	65 19	1749.7	930.2	13.67	12.88	25 41
" 3 tests........	6	6750	40.61	490.4	1196.[illegible]	17.73	17.53	28.74
" 3 tests........	6	2798	65.49	2914 3	481 6	17.51	18.97	34.72
" 3 tests........	6	2798	40.61	898.1	606.9	21.69	21.83	34.84
" 3 tests........	7	6750	40.76	644.3	930.5	13.78	13.16	26.79
" 6 tests........	7	2798	40.76	1211 4	462 3	16.52	15.07	30 02

The mean co-efficients of friction of the hard "Diamond S" brakeshoes tried were higher than those of the plain shoes cast from the same metal. In the case of the soft "Diamond S" brakeshoes the addition of the expended metal does not appear to materially affect the friction, the results not showing a uniform tendency either to raise or to lower the mean co-efficient.

The friction of the soft "Diamond S" brakeshoe tried is about the same as that of the "B.," "C." & "H." shoes of the M. C. B. Tests.

A Large Interlocking Plant.

The mammoth interlocking switch and signal plant at Hammond, Ind., was tested Nov. 14, and was found to work satisfactorily. The system is composed of 185 levers. The plant was made necessary by the recent crossing of the Western Indiana, Nickel Plate and Michigan Central tracks by those of the Chicago, Hammond & Western. The last named company is responsible for the construction of the system, but in consideration for being permitted to cross the Trunk lines the Western Indiana will operate the machine, and under the new arrangement it will have control of the switches, signals, and crossings of the following roads: Erie, Grand Trunk, Monon, Nickel Plate, Michigan Central, Wabash, State Line & Indiana City, Chicago Terminal Transfer, and the Chicago, Hammond & Western. Forty-eight thousand feet of pipe was required in the construction of the system, and 91,000 feet of wire was used to connect the levers and signals. One hundred and forty-five trains, or an average of 3,000 cars, pass over the State line every 24 hours, but it is expected to double this when the Chicago, Hammond & Western is completed, as the belt line will be the great artery connecting the Western roads with South Chicago and Hammond.

The Atlantic City Flyer.

There is a tendency on the part of some foreigners to discredit the remarkably fine records which the Atlantic City Flyer of the Philadelphia & Reading Railway has been making during the past summer. We are sorry for them; they do not know our methods of running trains and cannot understand how such things can be done, especially when they are prone to believe our railroads to be inferior in all respects to theirs, and, withal, rather dangerous to ride upon.

The publication of a note in one of our recent issues commenting upon this remarkable record called forth a protest from one of the most prominent engineers of England, who clearly does not believe the figures to be correct, and seeing the performance reported in the *American Engineer*, he immediately sent us a communication, which we are not at liberty to publish, asking for

Other doubters have expressed themselves through the correspondence columns of our contemporary, *The Engineer* of London, offering such ridiculous explanations for the records as that our mile is only 5,000 feet long. The Atlantic City Flyer does not require defense at our hands, but in order to enable the skeptics, who are doubtless honest in their convictions, to fully understand how the records were taken, and how the train is regarded here, and to show them just what we claim for it, we print the following letter from Mr. Theodore Voorhees, Vice-President of the road, which needs no further introduction:

Sir: I note the cuttings you inclose from *The Engineer* of London.

It is quite evident that their correspondents are not familiar with the ordinary practice of reporting trains on railways in this country. This train No. 25 was put on for regular business during the summer, and the trips made by it were not intended as in any wise test trips. The train was run under the ordinary conditions pertaining to the service of the road. It is customary for our telegraph operators to report the passing of all trains to the Superintendent's office to the nearest minute in each case. On account of the exceptional speed of No. 25, an endeavor was made to report the train as accurately as possible, and, therefore, reports were given to the nearest quarter minute. These reports were according to the ordinary station clocks, which instruments are regulated by telegraph once each 24 hours, and, of course, are not to be considered as absolutely accurate. No one will pretend for a moment that the reports on July 5 at Meadow Tower and Atlantic City, one minute for one mile and seven-tenths, are correct. An error is manifest in that report. It is possible that errors exist in the reports at other stations and on other dates.

The management of the road has never claimed that the intermediate speeds, as indicated by the train sheet, were absolutely correct. The departures of the train from Camden and the arrivals of the train at Atlantic City were recorded with great care and can be relied upon as accurate. These show an average rate of speed for the entire two months of sixty-nine (69) miles per hour from start to stop. That is correct beyond question.

The suggestion that our miles are short miles is too puerile to notice. Any educated engineer in England knows that the standards of distance are the same in this country as in Great Britain.

I hand you an official record of the train, showing the times as reported on the train sheet for both months, July and August, and also giving particulars in regard to the locomotive and the cars, together with a report as to the number of cars carried each day, the number of passengers and the average time.

THEODORE VOORHEES, Vice-President.

THE ATLANTIC CITY RAILROAD COMPANY,
OFFICE, READING TERMINAL.
PHILADELPHIA, Nov. 11, 1897.

Engine 1027, which made the run every day, was built at the Baldwin Locomotive Works, Philadelphia, and its general dimensions are as follows:

PERFORMANCE OF TRAIN NO. 25 FOR JULY AND AUGUST, 1897.

Copy of Train Despatcher's sheet, showing running time of train, to which is added a statement showing number of cars in train, number of passengers carried and average number of miles per hour r each trip.

JULY.

Stations.	Distance.	Schd. Time.	2d.	3d.	5th.	6th.	7th.	8th.	9th.	10th.	12th.	13th.	14th.	15th.	16th.	17th.	19th.	20th.	21st.	22d.	23d.	24th.	26th.	27th.	28th.	29th.	30th.	31st.
Camden	.0	3.48	3.50½	3.50¾	3.50½	3.50¾	3.51	3.50½	3.49½	3.49½	3.49¾	3.49	3.49½	3.50¼	3.51½	3.51½	3.51	3.51	3.50¾	3.50	3.49½	3.49	3.49	3.49½	3.48¾	3.49	3.49	3.50
West Collingswood	3.1	3.54	3.55	3.55	3.55	3.55	3.56	3.55	3.54½	3.54	3.54	3.54	3.54	3.54½	3.56	3.55½	3.55	3.55½	3.56	3.55	3.54½	3.54	3.54	3.54	3.53½	3.53½	3.54	3.55
Haddon Heights	5.5	3.56	3.57½	3.58	3.57	3.58	3.58	3.57½	3.57	3.57	3.56½	3.56½	3.56	3.57½	3.59	3.58½	3.58	3.58	3.58	3.57	3.56½	3.57	3.56½	3.56½	3.56	3.56	3.57	3.57½
Magnolia	7.9	3.58	4.00	4.00	4.00	4.00	4.00½	3.59½	3.59½	3.58½	3.59	3.58½	3.59	3.59½	4.01	4.01	4.00	4.00	4.00½	3.59½	3.59	3.59	3.59	3.59	3.58	3.58½	3.59	3.59½
Clementon	12.0	4.02	4.03	4.03½	4.03¾	4.03	4.04	4.02¾	4.02½	4.02	4.02	4.01½	4.02	4.02½	4.04	4.04	4.03	4.03	4.03½	4.02	4.02	4.02	4.02	4.02	4.01	4.01½	4.02	4.03
Williamstown June	17.0	4.06	4.07½	4.08	4.07½	4.07	4.08	4.07¼	4.06½	4.06	4.06	4.06	4.06	4.06½	4.08	4.08½	4.07	4.07½	4.07½	4.06	4.07	4.06	4.06	4.06	4.06	4.06	4.06	4.07
Cedar Brook	19.9	4.09	4.10	4.10¼	4.10½	4.10	4.10½	4.09½	4.09½	4.09	4.09	4.08½	4.08½	4.09½	4.10½	4.11	4.09½	4.09¾	4.10½	4.09	4.09	4.09	4.09	4.09	4.08	4.08½	4.09	4.09½
Winslow June	21.5	4.12	4.13½	4.14	4.14	4.13½	4.14	4.13	4.13	4.12½	4.13	4.12½	4.12	4.13	4.14	4.15	4.13	4.13	4.14	4.12½	4.12½	4.12½	4.12½	4.12¾	4.11¾	4.12	4.12½	4.12½
Hammonton	27.6	4.15	4.16	4.16½	4.16½	4.16	4.16½	4.15½	4.15	4.15	4.15	4.14½	4.14½	4.15	4.17	4.17½	4.15½	4.16	4.16½	4.15	4.15	4.15	4.15	4.15½	4.14	4.14½	4.15	4.15
Elwood	33.8	4.20	4.20½	4.21	4.21	4.20½	4.21½	4.20¼	4.20¼	4.20	4.20	4.19¾	4.19½	4.20	4.21	4.22	4.20	4.20½	4.21	4.19¾	4.20	4.19½	4.20	4.20	4.19	4.19	4.19¼	4.20
Egg Harbor	38.7	4.24	4.25	4.25	4.25	4.24	4.25	4.24½	4.24	4.24	4.24	4.24	4.23½	4.23½	4.24½	4.26	4.24	4.24	4.25	4.23½	4.21	4.24	4.21	4.21	4.23	4.23	4.23	4.23½
Brigantine June	43.5	4.28	4.28½	4.29½	4.29	4.28	4.29	4.28	4.28	4.28	4.28	4.27	4.27	4.27	4.28½	4.29½	4.27½	4.28	4.29	4.27	4.27½	4.27	4.27½	4.28	4.27	4.26½	4.26½	4.27½
Pleasantville	50.5	4.33	4.31½	4.35	4.31	4.31	4.35	4.33	3.33	4.33	4.33½	4.33	4.32	4.33	4.31	4.35¼	4.32½	4.33½	4.24¾	4.32¾	4.33	4.32½	4.33	4.33½	4.32½	4.32½	4.32	4.33
Meadow Tower	53.8	...	4.37	4.37	4.37	4.36½	4.37	4.35½	4.36	4.36	4.36	4.35½	4.34½	4.35	4.36½	4.37½	4.35½	4.36	4.37	4.35½	4.36	4.35	4.36	4.36	4.35½	4.35	4.35	4.35½
Atlantic City	55.5	4.40	4.38½	4.38½	4.38	4.37¾	4.38½	4.37½	4.37½	4.37½	4.37½	4.37	4.36	4.39	4.38½	4.39½	4.38	4.38	4.38½	4.37½	4.38	4.38	4.39	4.38½	4.38	4.38	4.37	4.38
Number of cars			5	5	5	6	5	5	6	6	5	5	5	5	5	6	5	5	5	5	6	6	5	5	5	6	6	6
Passengers carried			196	260	31	138	128	151	206	307	150	116	125	171	181	314	150	116	192	195	253	376	157	127	123	161	204	386
Running time			.48	.47¾	.47½	.47	.47½	.47	.48	.48	.48¼	.48	.47½	.48¾	.47	.48	.47	.47	.47¾	.47½	.48½	.49	.50	.49	.49¼	.49	.48	.47
Miles per hour (average)			69.3	69.7	70.1	70.8	70.1	70.8	69.3	69.3	69.0	69.3	71.6	68.3	70.8	69.3	70.8	70.8	69.7	70.1	68.6	67.9	66.6	67.9	67.6	67.9	69.3	70.8

AUGUST.

Stations.	Distance.	Schd. Time.	2d.	3d.	4th.	5th.	6th.	7th.	9th.	10th.	11th.	12th.	13th.	14th.	16th.	17th.	18th.	19th.	20th.	21st.	23d.	24th.	25th.	26th.	27th.	28th.	30th.	31st.
Camden	.0	3.48	3.51¾	3.51½	3.51½	3.50½	3.50¼	3.49½	3.50¼	3.50½	3.49¾	3.50	3.50¼	3.51¼	3.51½	3.51½	3.51¼	3.51½	3.51	3.51¾	3.49½	3.49½	3.49½	3.49½	3.49¾	3.49½	3.50¼	3.51
West Collingswood	3.1	3.54	3.56	3.56½	3.56	3.55½	3.55	3.54	3.55	3.55½	3.54½	3.55	3.55	3.56	3.56	3.56	3.56	3.55½	3.56	3.57	3.54	3.54	3.54	3.54	3.55	3.54	3.55	3.55
Haddon Heights	5.5	3.56	3.59	3.59	3.59	3.58½	3.57½	3.56½	3.57½	3.58	3.57	3.57	3.57½	3.58½	3.59	3.58½	3.58	3.58	3.58½	3.59	3.56½	3.57	3.56½	3.56½	3.57½	3.57	3.57½	3.58
Magnolia	7.9	3.58	4.01	4.01	4.01	4.00½	3.59½	3.59	3.59½	4.00½	3.59½	3.59½	3.59½	4.01	4.01	4.01	4.00½	4.00½	4.00½	4.01½	3.59	3.59	3.59	3.59	4.00	3.59	3.59½	4.00
Clementon	12.0	4.02	4.04	4.04½	4.04	4.03½	4.03	4.02	4.02½	4.03½	4.02¼	4.02½	4.03	4.04	4.04¼	4.04	4.03¾	4.04	4.04	4.01¾	4.02½	4.02	4.02	4.02	4.03	4.02	4.02½	4.03
Williamstown June	17.0	4.06	4.08½	4.08½	4.08½	4.07½	4.07¼	4.06	4.07	4.08	4.07	4.06½	4.07	4.08	4.08¾	4.08	4.08	4.08	4.08	4.09	4.06½	4.06	4.06	4.06	4.07	4.06	4.06½	4.07
Cedar Brook	19.9	4.09	4.11	4.11	4.12	4.10¼	4.09½	4.09	4.09½	4.10½	4.09	4.09	4.09½	4.11	4.11	4.10½	4.10½	4.10½	4.10½	4.12	4.09	4.09	4.08¾	4.09	4.09½	4.09	4.09	4.10
Winslow June	21.5	4.12	4.14½	4.15	4.14½	4.13½	4.13	4.12½	4.12½	4.14	4.12½	4.12½	4.13½	4.14½	4.14¾	4.14	4.13¾	4.14	4.13½	4.15	4.13	4.12½	4.12½	4.12½	4.13	4.12	4.12½	4.13½
Hammonton	27.6	4.15	4.17	4.17	4.17	4.16	4.15	4.15	4.15	4.16½	4.15	4.15	4.15½	4.17	4.17	4.16½	4.16½	4.16½	4.16	4.17½	4.15	4.14½	4.14½	4.14½	4.15½	4.14½	4.15	4.15½
Elwood	33.8	4.20	4.21½	4.21¾	4.21½	4.20½	4.20	4.20	4.20	4.21¼	4.19½	4.20	4.20	4.21½	4.21½	4.20½	4.20½	4.21	4.20½	4.22½	4.19½	4.19½	4.19	4.19½	4.20	4.19	4.19½	4.20
Egg Harbor	38.7	4.24	4.25	4.25	4.25	4.24	4.24	4.21	4.23½	4.24½	4.23	4.24	4.23½	4.25	4.25½	4.24½	4.24½	4.25	4.24	4.26	4.23½	4.23	4.23	4.23	4.24	4.23	4.23	4.24
Brigantine June	43.5	4.28	4.29	4.29¼	4.29	4.28	4.27	4.27	4.27	4.28	4.27	4.27	4.27½	4.29	4.29	4.28	4.28¼	4.28½	4.27¾	4.30	4.27	4.27	4.26¾	4.27	4.27½	4.26½	4.26¾	4.27¾
Pleasantville	50.5	4.33	4.31	4.34½	4.34½	4.33	4.33	4.33	4.33	4.34	4.32¾	4.33	4.33	4.35	4.31½	4.33½	4.31	4.31½	4.33	4.35½	4.32½	4.32	4.32½	4.32½	4.33½	4.31½	4.32	4.33
Meadow Tower	53.8	......	4.36¾	4.37¼	4.37	4.36	4.35½	4.35½	4.35½	4.37	4.35	4.35½	4.35½	4.37½	4.37½	4.36½	4.36¼	4.36½	4.35	4.38	4.35	4.35	4.35	4.35½	4.36	4.34	4.35	4.36
Atlantic City	55.5	4.40	4.38½	4.39	4.39½	4.38½	4.37½	4.37½	4.38	4.38½	4.37¾	4.38	4.37¾	4.39¼	4.39¼	4.38¼	4.38¾	4.38½	4.37¾	4.40	4.38	4.38	4.38½	4.38½	4.38½	4.37¾	4.38	4.37¾
Number of cars			6	6	6	6	6	6	5	6	6	6	6	6	6	6	6	6	6	6	6	6	5	6	5	6	5	5
Passengers carried			252	238	265	185	286	383	223	262	257	283	292	118	267	292	236	232	276	396	178	190	211	195	259	370	117	166
Running time			.46¾	.47½	.48	.48	.47¼	.48	.47¾	.48	.48	.48	.47½	.48	.47¾	.46¾	.47½	.47	.46¾	.48¼	.48½	.48½	.49	.49	.48¾	.48¼	.47¾	.46¾
Miles per hour (average)			71.2	70.1	69.3	69.3	70.4	69.5	69.7	69.3	69.3	69.3	70.1	69.3	69.7	71.2	70.1	70.8	71.2	69.0	68.6	68.6	67.9	67.9	68.3	69.0	69.7	71.2

Philadelphia & Reading Train between Philadelphia and Atlantic City.

Gage ... 4 feet 8½ inches
Cylinders, high pressure ... 13 by 26 "
" low " ... 22 by 26 "
Height of drivers ... 84¼ "
Total wheel base ... 26 feet 7 "
Driving wheel base ... 7 " 3 "
Length of tubes ... 13 feet
Diameter of boiler ... 58¾ inches
" " tubes ... 1¾ "
Number of tubes ... 278
Length of firebox ... 113⅞ inches
Width " " ... 96 "
Heating surface of firebox 136.4 square feet
" " " tubes 1,614.9 " "
Total heating surface ... 1,835.1 " "
Tank capacity ... 4,000 gallons
Boiler pressure, 200 pounds per square inch
Total weight engine and tender, 227,000 lbs.
Weight on drivers (about) ... 78,600 pounds
" of combination car. 57,200 "
" " each coach ... 59,200 "
" " Pullman car ... 85,500 "

Progress in Street Car Construction.

That the progress in the construction of railway cars has not been confined to those used on steam roads is very clearly shown by the illustrations presented herewith. These photographs were received through the courtesy of Mr. H. H. Vreeland, President of the Metropolitan Street Railway of New York, and they show the great differance between the cars of 40 years ago and of the present time. One of the engravings shows an old car which formerly ran on the Eighth Avenue line and was built like a

Forty Years Ago.

stage coach. It is a coach body set on a four-wheel truck. The body is about eight feet long and about five feet wide and will accommodate six passengers inside and six more on the roof.

The new cars are the antithesis of the old ones and represent the latest work of the well-known builders Messrs. J. G. Brill Company, of Philadelphia. These are 28 feet long and 7 feet 6 inches wide. There is nothing very striking about the inside finish, which is the Broadway standard pattern of solid white ash with veneer ceilings decorated, and with chipped beveled edge glass and ventilators. The seats are of wood and the backs are covered with Wilton carpet of a handsome pattern. They are provided with Brill's improved and patented angle iron bumpers, ratchet brake handles, pedal alarm gongs, and radiating draw bars. There will be 50 of these cars, which include an order for 30 now building.

The trucks are the Eureka maximum traction type, as shown in the large engraving, which was designed specially for use where loads are heavy and stops are frequent.

The truck consists of a solid frame carrying two axles and four wheels. The wheels are of unequal diameter, two of large size being used as driving wheels, while the idle or pony wheels are small. The leading and striking feature of the truck is the eccentric disposition of the load, which is so placed as to bring 80 per cent. upon the driving wheels, leaving on the pony wheels only so much as is necessary to guide the truck. There is no transom nor center plate. The side bearings take the whole load, while king or draw pins working in radial plates transmit the power to the body and guide the truck. Brakes are applied to all the wheels. A very short wheelbase is obtained, and by bringing the end piece of the frame inside the pony wheels the whole length of the truck is reduced to the least possible amount. This enables the low end of the truck to clear the steps when swinging on curves.

Placing 80 per cent. of the weight on the driving wheels leaves 20 per cent. for guidance of the truck. With two motors to a car this gives as great a tractive force as is needed under any ordinary conditions. In practice it is found to be nearly as great in its effectiveness as that of a four-wheel car. This is due to the steadiness imparted by two trucks, and the fact that the pony wheels in snow, etc., clear the way for the drivers. The load being placed in an eccentric manner upon the wheels, according to the builders, is found to give at least 25 per cent. greater tractive effort than can be obtained from other four-wheel center-pivot trucks with a single motor.

A New Brill Electric Car.

Sanitation of Passenger Cars.

The subject of fumigation and disinfecting, as applied to passenger cars, has been discussed before two of the railroad clubs, and its great importance is apparently becoming better appreciated. Mr. Wm. Garstang, Superintendent of Motive Power of the C. C. C. & St. L. Ry., is one of the foremost in promoting the sanitation of the cars under his direction, and below we quote from a paper on the subject presented by Mr. J. A. Gohen before the St. Louis Railway Club, which describes the practice on that road.

The only reason one can assign for cars not properly cleaned is the cost, hence it is the rule to keep that cost down to the lowest possible limit. The result is that the person in charge has more work to do than can be consistently and well done, consequently much of it is left undone.

Every other part of the maintenance of equipment seemingly has a guardian angel presiding over its destinies, and, cleaning being neglected, is uncharitable enough to uncover a multitude of sins. The average official who is growing gray through worry over his fuel, oil and waste accounts, and who is seeking improvement in that line, never stops to think there is money to be saved to his company in practical, consistent and common-sense cleaning.

He never think of the damage that ensues from a senseless, heroic style of cleaning, unless an aggravated case comes under his observation, then a reprimand is supposed to prevent a recurrence. Better remove the cause than try to prevent a repetition. The president, manager or superintendent who fails to investigate the method of cleaning at terminals, or who, when riding over the system in his special car, does not go forward to the smoker, or other day coaches, cannot be aware of their condition.

Those of you who have watched the cleaning of coaches at terminals know full well that the average cleaning is very detrimental to such elastic and sensitive articles as varnish and paint, and you know the average cleaner cares little about what he uses so that it cleans and cleans quickly. He only knows that strong soap is the thing to do it quickly, and he learns that concentrated lye, sal soda and ammonia are quicker, consequently they are the ever-ready agents resorted to when in a hurry, which is generally the case at all times. I have on more than one occasion witnessed the baneful results of such pernicious practice. I have a vivid recollection of a road, with which I was connected several years ago, placing in service four new vestibuled trains in the month of May. The road, at that time, did not own or control the terminal where these cars were cleaned. They were very exacting, however, in the matter of cleaning, and the terminal company met their demands in a heroic manner. In October of that same year these cars had to be sent to the shops for repainting, and from no other cause than a senseless method of cleaning. Perhaps you will say this was a costly and bitter experience. On the contrary, it was a blessing in disguise, for it brought these people face

to face with a condition which they did not realize ever could or would exist. A reform was immediately instituted that dispensed with strong soap and water, pumice stone, acid and alkali. A practical method was adopted from which no deviation was made, except to improve it, where possible, and they are well satisfied with the results obtained, as it has materially lessened the cost of painting and has assured them handsome, cleanly and healthful equipment that meets the approbation of their patrons. In addition to this, it has engendered a spirit of pride in all its employees that assists materially in maintaining an equipment that is hard to excel, and the encomiums they receive is an ample return for the money expended. It is a first-class advertisement.

We find it better to have the cleaning force an exclusive one. Let it be understood that they are to do cleaning and nothing else, and they will soon become practical and efficient. On the contrary, if you expect your cleaners to do other work, such as oiling, inspecting and laboring, and to do cleaning when not engaged in the other duty, you will find that your cleaning will be spasmodic, inefficient, worthless.

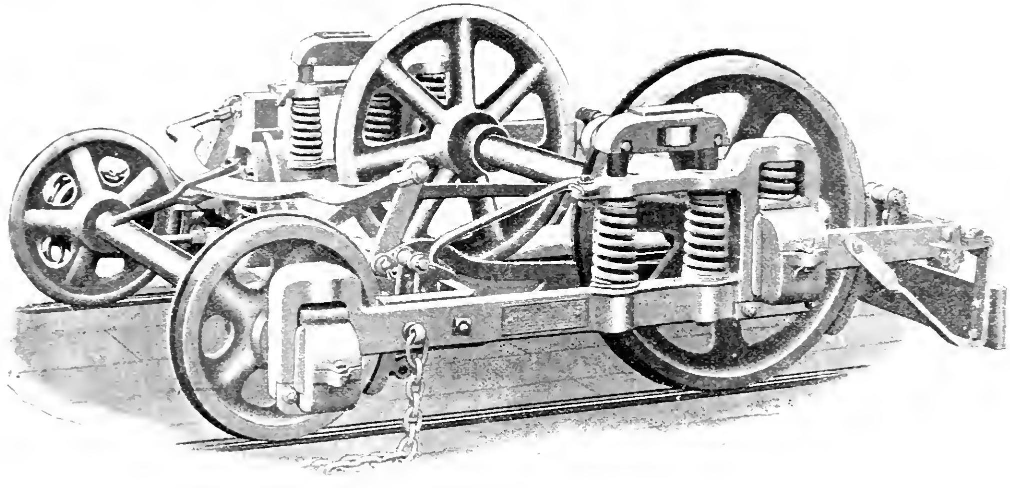
The cleaning force should be under the immediate control of the general foreman of terminals. If the paint shop is contiguous to the terminal, the foreman painter should determine the method of cleaning, and should give reasonable supervision to same. He is certainly interested in the preservation of his work after leaving shop, and no one is more capable of supervising it. If the paint shop is remote from the terminals, a shop painter should be placed at the head of the cleaning force. It would not require one of the best, however, a medium grade one would answer.

As to the sanitation of passenger cars, I do not feel disposed to suggest to the railways the duties they owe to the public at large in the preservation of health. It would be presumption on my part to do so. However, the day is not far distant when the sanitary condition of passenger cars will be greatly improved as the State boards of health of the different States are looking into this matter, and you had better get your equipment ready for inspection.

I take pleasure in appending a copy of the rules and regulations governing the cleaning and sanitation of passenger cars at the terminals, which has lately been issued by our company, leaving out the special instructions to terminals. By these you will see that we are attempting at least to provide for the sanitation of our coaches, and will say that same have been submitted to the Secretary of the State Board of Health of Indiana, who has approved them.

CAR CLEANING RULES.—C., C., C. & ST. L. RAILWAY.

1. All passenger coaches must have doors and windows opened immediately on arrival at cleaning yards, the same to remain open until departure or nightfall, except in stormy weather.
2. Seats and backs thoroughly dusted and cleaned by air where practicable; seat arm rests, where finished in wood, to be washed off with solution of formaldehyde each trip of 100 miles or more.
3. Dust out or wipe off inside of car each trip of 100 miles or more. Scour inside of water coolers once a week with hot water. Every 30 days clean the interior of car with a weak solution of modoc powdered soap, mixing as follows: One pound of powdered soap to six pounds of water.
4. Oil lamps to be filled, trimmed and cleaned each trip of 100 miles or more. Pintsch gas lamps cleaned and tips examined each trip of 100 miles or more.
5. All saloons must be scrubbed, urinals thoroughly cleaned and both disinfected each round trip of 100 miles or more with formaldehyde, as follows: One pint of the solution placed in five gallons of clean water; agitate until a perfect mixture is assured. Spray with sprinkling can the floor, inside of hopper, urinal and walls of saloon. Can containing solution to be kept closed when not using, so as to retain full strength.
6. Clean and wipe windows with tripoli and waste for each 100 miles or more.
7. Wipe off body and trucks of car each trip of 100 miles or more, and for every 2,000 miles made, clean body of car with modoc liquid cleaner.
8. Parlor, buffet and dining cars to be treated the same as coaches, except cleaning the carpet, which must be taken up and dusted and cleaned every second trip. Food boxes and refrigerators in buffet in dining cars to be cleaned and treated with formaldehyde once a week during the summer months.
9. Combination parlor and sleeping cars, when in use, to be treated the same as coaches and straight parlor cars, except bedding, which must be removed, thoroughly cleaned and aired each trip.
10. Private and pay cars to be thoroughly ventilated each day while in yards by opening windows—keeping doors locked—and should not be cleaned until notice is given that they will be required for service. Food boxes and refrigerators in these cars to be treated the same as those in buffet and dining cars.
11. All extra or unassigned passenger equipment stored at terminals must be kept well ventilated and presentable at all times.
12. Sample of drinking water used in passenger equipment cars must be sent from each terminal to the Superintendent of Motive Power, to be analyzed, every six months, and oftener if the foreman in charge has any doubt as to its purity. Foremen must report to the Master Mechanic any and all cars requiring shop attention.



The Eureka Maximum Traction Truck.—The J. G. Brill Company.

In the discussion of Mr. Gohen's paper the author stated that the expense for thorough cleaning did not exceed from 15 to 17 cents per 100 miles run, and on the Chesapeake & Ohio, which road, owing to the work of Mr. W. S. Morris, Superintendent of Motive Power, has the reputation of having the cleanest cars to be found, the cost is 28 cents per 100 miles.

The subject of car sanitation embraces the cleaning by disinfecting solutions, as already described, and also fumigating, and the following paragraphs are taken from the proceedings of the Western Railway Club of October, 1897, as showing the methods used for accomplishing this:

Mr. F. W. BRAZIER (Illinois Central): Having been asked to give the method of disinfecting passenger equipment on our system, I will briefly, yet clearly as possible, explain it.

Our passenger equipment is disinfected by the gas of formaldehyde, which is produced by the following formula: 8 ounces calcium chloride, 1 pint water, 2½ pints formaldehyde. Dissolve the chloride in water, filter and mix with formaldehyde. The above quantity is required to fill an empty generator to its capacity; 1½ pints must be in the generator at all times, when the generator is in use, to insure safety. A regular charge, the quantity of which can be entirely used without refilling, amounts to 2 pints of the solution. Formaldehyde gas is made by boiling the above mixture in a C Formal generator No. 1 with a Primus No. 1 apparatus. To obtain the necessary amount of vapor to fumigate a car, the liquid is boiled until it reaches a pressure of 45 pounds; it is then applied to the car. The time required to obtain 45 pounds pressure is about 20 minutes. When our trains arrive at the terminals we take them immediately to our cleaning yards, close all windows and doors, open the toilet-room doors, and, in sleeping cars, open all the

berl hs, and doors to closets and inside rooms. We then inject the formaldehyde gas by inserting the tube through the keyhole of the outside door. The time used in application is as follows:

Class of car.	Time of application.	Cost Material.	Cost Labor.	Total Cost.
Baggage	15 minutes.	18½c.	8c.	26½c.
Mail	20 "	24⅔c.	9c.	33⅔c.
Coach	20 "	24⅔c.	9c.	33⅔c.
Sleeping	30 "	37c.	11c.	48c.

The cars are kept locked 4½ to 5 hours, then they are opened and thoroughly ventilated. The odor of the formaldehyde quickly disappears. We then clean the cars, scrub the floors, clean out all water tanks and toilet rooms. When the cars go into service fresh water is supplied to all tanks for drinking water.

In answer to the question if formaldehyde gas affects paint, varnish or textile fabrics, I will quote from part of the Public Health Reports to the United States Treasury Department under date of Jan. 29, 1897: "While this gas stands as the best known germicidal agent, it also commends itself for the purpose, in that it has no detrimental effect upon the finest textile fabrics, upon colors, the finish of household furniture, pictures or tinsels. It will not attack gold, silver, copper, brass or zinc, but does excite oxidation in steel and iron. It does not injure paint or varnish, hence it is especially valuable, inasmuch as contaminated rooms may be disinfected without special preparation or removal of articles." It will thus be observed that this gas will not injure the inside finish of the cars. Under the advice of the State Board of Health we have continued this system on our road.

It would not be out of place to state that we give our passenger equipment a thorough cleaning after it is disinfected. Seats and seat backs are dusted and cleaned by air, when practicable. The floors are scrubbed out at each terminal, oil lamps filled and trimmed each trip, particular attention is paid to urinals, to keep them thoroughly cleaned, and a solution of water and formaldehyde is sprinkled on the floor, one pint of formaldehyde to four gallons of water.

Dr. J. N. Hurty, C., C., C. & St, L. Ry.: It certainly is a wise thing for the railroads to take hold of car sanitation. It seems to me probable that unless the railroads do take hold of it voluntarily and lead in the matter, the first thing you know they will have some legislation on the subject.

The Big Four system has been disinfecting in this way: First, they clean thoroughly in the ordinary manner by sweeping out and washing off the floors, scrubbing, and then applying an antiseptic floor dressing, then by washing off the arm rests when these are of wood, the window ledges, etc., where children might crawl and deposit their saliva, which is a great method of propagating diphtheria. If a diphtheritic child, with the diphtheritic germs still in its throat, deposits some of its siliva upon an arm-rest and then another child comes along and gets it in its throat, on goes the diphtheria. That is one of the main methods by which it is propagated. So after sweeping and mopping and applying the antiseptic oil as often as is necessary, and washing the arm-rests and then washing the window ledges, they go over them a second time with a two per cent. solution of formaldehyde which is distributing it in close spots; then they have invented a spraying apparatus in which they take a one or two per cent. solution of formaldehyde and with the compressed air in the cylinders underneath the car they spray every seat thoroughly. It does not injure any of the finish of the car or any of the metal or the plush; in fact, the most delicate colors are not injured by the formaldehyde. So a one or two per cent. solution of formaldehyde is thoroughly sprayed into all the plush. The car is allowed to remain closed for at least five or six hours, perhaps longer if it is possible, before it is aired out.

In addition to that, there is an arrangement made by which every month they will fumigate thoroughly to the extent of the United States requirements. Perhaps it would be better to do that at the end of every trip; however, the expense would be very great and it is possibly uncalled for because of the other disinfection.

The speaker described the wood alcohol apparatus and stated that if the chimney was removed the lamp burned with the usual alcohol flame and the production of carbonic acid gas and water, but when the divided chimney was put on the products of combustion were thrown back upon the flame and converted into formaldehyde gas. He stated the cost of fumigating to be 33 cents per car per application and said that the gas was not injurious to human beings, though it could be depended upon to kill bacilli.

To illustrate the method whereby disease may be propagated upon trains, he said:

There was in Indianapolis a child recovering from diphtheria; the diphtheritic infection was yet in its throat, and by order of the health department a quarantine had been laid and the parents had been told that the child must not go to school as long as the infection was not gone from the throat. If the child had gone to school, it would readily have left some saliva upon the edge of the cup, or with its fingers upon the slate, would transfer it from the slate to the top of the desk and in that way make it very risky for the other children, therefore it was ordered that the child should not go to school, and the parents were watched pretty closely by the sanitary officers. But what did they do but bundle up and go down to Louisville. Now it happened to be the day before the opening of school (that was a year ago this fall), and teachers who had been to teachers' institutes were returning to their schools. Very shortly after these teachers had opened their schools, in four separate places along that line, diphtheria broke out in the schools. That is coming pretty close to proving one thing, namely, that the teachers had drunk from the same cup as the child, or that the child, as children do, had been squirming around, getting its fingers into its mouth and getting its saliva on the arms of chairs, or the ledges of windows, and they had thus become infected. That is the most remarkable instance of spreading diphtheria, and it does look very much as if these four school teachers had become infected on that train, for it was within the specified time, about six or ten days, that diphtheria broke out in their schools. These teachers did not have diphtheria, but they did have diphtheritic organisms in their throats when they were examined. We now know on what precipices we live with regard to these infectious diseases, and surely now, since we have found out how these diseases are spread, we should aim to prevent them.

Centers of Gravity of Freight Cars and Trucks.

The height of the center of gravity of several types of cars above the tops of the rails upon which they stand is given by Mr. R. A. Parke, in a paper read before the New York Railroad Club, as they were taken by Mr. A. S. Vogt, Mechanical Engineer of the Pennsylvania Railroad. The car bodies and trucks were suspended for the purpose of making these determinations, which are given as follows:

Class of Car.	Weight.	Height of center of gravity above top of rail.
P. R. R. box	32,000	66 inches.
*P., C., C. & St. L. stock	26,000	67¾ "
P. R. R. hopper bottom gondola, with sides 47 inches high	26,100	46¾ "
P. R. R. drop bottom gondola, with sides 36 inches high	25,900	43¾ "
P. R. R. hopper bottom gondola, with steel bolsters and longitudinal truss rods	26,700	45½ "
*P., W. & B. flat	21,200	42½ "
P. R. R. 4 wheel caboose	....	37¼ "
†P. R. R. 4 wheel passenger truck	....	21 "
P. R. R. 4-wheel freight truck	5 500	19½ "

*Without air-brakes. The application of air-brakes would slightly lower the center of gravity.

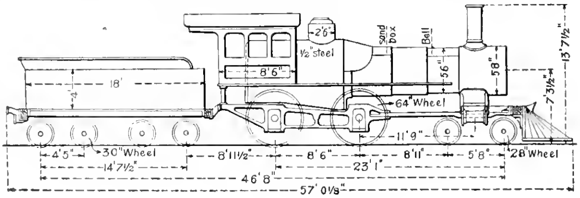
†As there was no load upon the springs, the truck frame was higher, with respect to the equalizers, boxes, wheels and axles than is the case in service. This would give a slightly higher center of gravity than that in service. In service, the center of gravity of the truck would probably be about 20½ inches.

The heights of the centers of gravity are all measured from the top of the rail. The cars were all *without* trucks, except the caboose, but the weights given include the trucks.

New Eight-Wheel Suburban Locomotives—New York Central.

The New York Central & Hudson River Railroad recently ordered 10 eight-wheel suburban locomotives from the Schenectady Locomotive Works, of which we show a diagram and give the chief dimensions. The fuel will be hard coal, which is made necessary by their being used for suburban work:

Weight, engine, working order	110,000 pounds
" " on drivers	77,000 pounds
" " on truck	33,000 pounds
" tender, loaded	78,000 pounds
Driving wheels, diameter	64 inches
Cylinders	18½ inches by 22 inches
Steam port	1¼ by 16½ inches
Exhaust port	2½ by 16½ inches



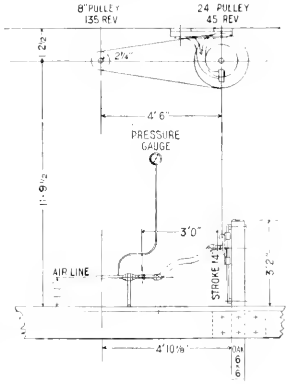
New York Central Suburban Engine.

Bridges	1⅛ inches
Valves, travel	5½ inches
" outside lap	⅞ inches
" inside lap	$\frac{1}{32}$ inches
Exhaust nozzle, double diameter	3¼ inches
Boiler diameter, smallest ring	56 inches
" pressure	160 pounds
Firebox, length inside lap	111$\frac{1}{16}$ inches
" width "	40⅞ inches

Flues, number	254
" outside diameter	2 inches
" length	11 feet 7 inches
Total heating surface	1,743 square feet
Grate area	32.6 square feet
Driving journals	$8\frac{1}{2}$ inches by $10\frac{1}{2}$ inches
Coal capacity, tender	6 tons
Water " "	3,500 gallons

Air Hose Testing Machine—C., M. & St. P. Ry.

Among the interesting machines recently devised for testing air-brake hose is that which is in use at the shops of the Chicago, Milwaukee & St. Paul Railway, and was designed to vibrate the hose while under pressure. The drawings are sufficiently clear to permit the construction to be understood at a glance. A reducing valve is put in the air pipe, through which the air passes before it reaches the manifold, to which the hose is attached. This reduces the pressure from 80 to 100 pounds on the air main to 65 pounds on the hose, that being the standard pressure carried on the train pipes on the cars.

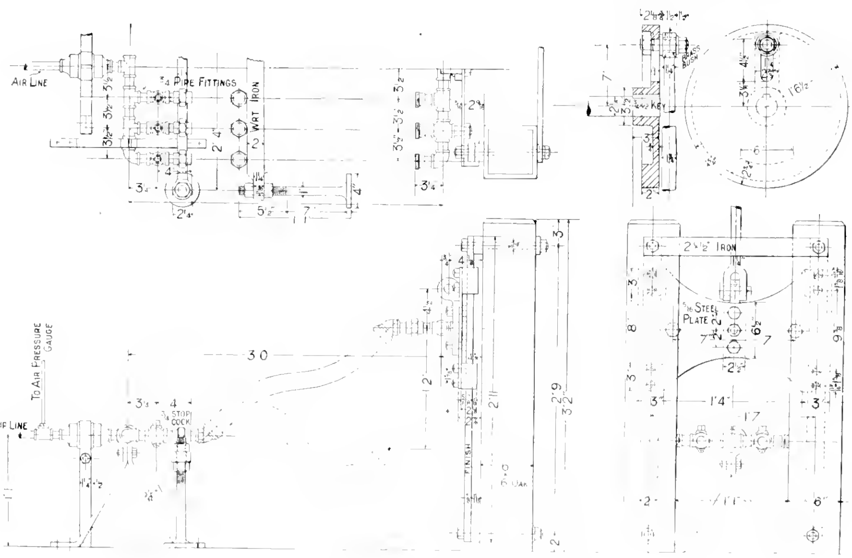


Air Hose Testing Machine.

The rack is fitted for testing six pieces of hose at a time. The stroke of the machine was made 14 inches because this is about the maximum amount of vibration that may be given to a 22-inch hose, and being the vibration used in the earlier machine it was also used in the present one. The testing machine is located in the physical testing room at West Milwaukee, and all the tests are made under the direction of the attendant in charge of the room, who takes a careful record of the tests, noting any defects that may appear in the hose which is kept on the rack where it vibrates at the rate of 45 strokes per minute until it bursts and allows the air to escape.

It would be very interesting to have the records of some of the tests to reproduce here, but this information is not available. One of the interesting features that have been brought out in the tests is the great differences in the temperatures attained by the different makes of hose during the tests. The different styles of hose and the different methods of making it are said to have a marked effect in this particular. Some makes are shown to be flexible and these do not increase much in temperature, while others of a hard and stiff character become very hot.

There are many questions of great value to be settled by such a machine and the great importance of obtaining the very best air-brake hose warrants the trouble of going into it in this way. The main object of the tests is to reproduce the conditions of service as nearly as possible in the tests and to wear the hose to destruction within a time that will permit of taking records. We are indebted to the courtesy of Mr. A. E. Manchester, Assistant Superintendent of Motive Power of the road, for the drawings and information concerning this machine.



Air Hose Testing Machine.—C., M. & St. P. Ry.

A "Perfect" Truck for Passenger Cars.

In our August issue, 1896, page 193, we presented an illustrated description of the "Perfect" passenger car truck as manufactured by Messrs. J. G. Brill & Company, of Philadelphia, and readers are referred to that description for illustrations showing the design and method of construction used.

A pamphlet has just been received from these builders containing information pertaining to this type of truck. Besides describing some of the important mechanical features, the circular gives a series of letters received from railway men who have these trucks in operation. These letters are worthy of special attention, because they give the experience of practical railway men who have been using this truck. In some cases they have been employed on lines nearly 50 miles long where a speed of 40 miles an hour is maintained.

One remarkable feature should not be overlooked. Although there are 500 of these trucks now in service, yet the almost universal expression of the letters is that they have never been off the track. Up to the present writing, Nov. 5, 1897, no case of derailment has been reported. This is the more remarkable because the trucks have been fitted with narrow tread wheels, having shallow flanges suitable for street car rails.

Steam railroad men will be interested in the fact that on the Oakland, Alameda & Piedmont Railway (now the California Railway), of Oakland, Cal., these trucks are used under standard 50-foot steam railroad car bodies, which weigh 50,000 pounds. This is practically steam service and the trucks are giving the best satisfaction.

Those who visited Niagara Falls at the recent convention had ample opportunity to test the ease with which these trucks pass sharp reverse curves (70-foot radius) at 30 miles per hour.

The Future of American Railroads.

In an address by Mr. M E. Ingalls, President of the "Big Four" system, before the students of Purdue University, November 22, the subject of American railroad problems was presented with such clear thought and admirable expression that we would like to give our readers the opportunity to see it in full. After considering the conditions existing at the time of the first railroad construction and the causes leading to them, the speaker gave a detailed account of the vast proportions to which railroad industry had reached and went carefully into the causes which had led to the adverse legislation that is now a menace not only to further development but to the conduct of railroad business in the interests of the masses of the people. The following paragraphs are taken from the conclusions of the speaker:

What is the future? There must be changes in legislation and in the management of railways. Some plan must be adopted to increase the ownership in railways by parties residing along their lines. The first great step toward doing this must be a reform in the tax laws, so that citizens of Indiana or other States can be put upon as favorable terms for ownership of bonds and stocks in a railway as citizens of New York. Greater permanance must be given to the condition and ownership of railways. It would be a great step if we could adopt the English method and create debentures instead of bonds, or in other words, provide that there should be no foreclosure for non-payment of interest. Such a thing as foreclosure of a railway in England is unknown. If the interest is not paid upon the debentures there may be a receiver of the profits, but the stockholder still holds his interest in the property. Here with our system of bonds, if there come a few bad years when the interest is defaulted, the bondholder takes possession and sells it under his mortgage, the interest of the stockholder is extinguished, and when prosperity returns he has lost his opportunity to get his share of it. This makes the possession of railway stocks speculative and uncertain; in fact, for years they have been more subject to assessments than to the receipt of dividends. If our form of mortgage could be changed to that of the English debenture, it would stop the immense number of reorganizations and would prevent values being wiped out in times of panic and would encourage investment by the people in the securities of these enterprises; for after all, that is the real improvement that is to come. The New England railways have less trouble with legislatures and courts, chiefly because they have a great many small holders of stocks along their lines and in the cities, each of whom is an agent of the corporation and aids in creating public sentiment and procuring fair treatment; while in the great central States and in the West there are scarcely stockholders enough to provide the officers for a stockholders' meeting. The railway officials themselves must be taught to conduct their business with care and with due respect to the rights of the people. Their actions must not be secret, but above board and open to the public. There must be but one rate to everybody, and that must be reasonable, and the legislatures must provide remedies by which railway officials can agree with each other on these rates and their contracts can be enforced. The present State and national laws in reference to railways are crude and crazy patchworks passed in some cases out of revenge for wrongs, real or fancied, and in others for political effect, and all in opposition to the railways.

The improvement of the country demands that the great articles of export, like cotton, wheat, flour, corn and meats, should be carried at the lowest possible rates. The railways should pattern after the English system, and, while making extraordinarily low rates for these great articles, should exact a terminal upon the higher classes of freight and upon freight carried short distances, so as to provide interest upon the immense terminals they have to have.

Passenger rates are made entirely upon the wrong basis. We charge the same for the man who rides in the palace car, and for whom the railway has to haul two tons of dead weight, as we do for the man who rides in the ordinary coach, and for whom only one-half a ton of dead weight is hauled. We charge practically the same for the passenger who is carried 60 miles an hour on the fast and expensive train as we do for the passenger upon the slow and less expensive train. These rates should be changed and graded.

Above all, a better understanding must be arrived at with the vast army of employees. They must have greater interest in the success of the railways and they must be a part of the power that will produce a better understanding with the communities which the railways serve. This must be done by a system of hospitals, pensions and profit-sharing.

Probably locomotives propelled by electricity will come in the future. If not, something else may. And we cannot tell what the next years have in store in the way of improving our railway facilities. Higher speed, possibly cheaper trains, but it is necessary to this country of ours that the railways should be encouraged so that they may go on improving their systems, so that branch lines can be built to every county seat in the country. Instead of stopping at 182,000 miles of railway we should at least build five thousand miles a year in short and inexpensive lines as feeders to the main systems, so that the days of the stage coach and the heavy wagons should be unknown. This country will soon have one hundred millions of people. It will require at least 250,000 miles of railways to serve them properly — an increase of 40 per cent. over the present mileage. They cannot be built, they cannot be improved and increased, with the present system of legislation and with the present prejudices against them. The development of the country demands that this must be changed. It is through such institutions as this, it is through such students as these, that the change must come. In the centuries that have gone, the youth of the various countries sought fame and preferment in war and its accompaniments. We live in better days and in a higher civilization, but the service of our railways offers a wider field for advancement and for fame than anything of old. The road to success in this line is not through carnage and suffering, but it is none the less sure, and requires equally moral courage and intelligence. A new evangel must be preached in reference to railways; they must be placed upon a higher order, and instead of being pariahs in business they must be the benefactors and friends of all.

The Walker Company.

The entire stock and property of the Walker Company, Cleveland, O., has just been acquired by four prominent New York business men, Messrs. Roswell P. Flower, Perry Belmont, J. W. Hinkley and Anthony N. Brady. The capitalization of the company is $2,500,000 and the bond issue $1,500,000. One of the principal owners was Mr. J. B. Perkins, of Cleveland, he having stock to the value of nearly $2,000,000. His interest, as well as that of the former president, Mr. Billings, is taken entirely. The stock of Mr. Sidney H. Short, the vice-president and electrician, is also taken, although he does not change his active relations to the company. The officers remain the same. The capital represented is almost limitless, and the result of this transaction is to be the development of the Walker Company into the greatest electrical manufacturing concern in the world. Elsewhere in this issue a statement is presented of the high regard in which American electrical apparatus is held abroad, and with the combination of the business ability of these men, the engineering experience of Mr. Short and the excellent plant at Cleveland, covering 12 acres, the Walker Company will doubtless be a very strong factor in electrical development at home and abroad.

It would be a very difficult matter, even if anyone was so disposed, to refute the statements of Mr. Charles E. Wheeler in his paper on the Commerce of the Great Lakes and presuming them to be correct there is a great deal in them for railroad men to think about. Further reference will probably be made to them in our pages, but at present we shall only call the attention of our readers to the paper which is reproduced nearly in full in this issue for the special purpose of presenting the question as to whether it is not possible for locomotive men to reduce the lead which the marine engine now enjoys as an economical machine.

A new illuminant is reported upon by Consul Deuster, of Crefeld. Mr. Ernest Salzenberg, director of the gas works of the city of Crefeld, has invented an improvement in incandescent gas burners, which relates to the production of incandescent gaslight, based upon the discovery that, when the pressure of the gas is considerably increased upon the incandescent body, that body emits a golden-yellow light very agreeable to the eye, displaying objects in their natural colors. The gas is supplied to the burner at a pressure of about 3½ atmospheres, the burner, to withstand this high pressure, being of special construction. A single incandescent jet of the ordinary size can emit a light of much more than 1,000 candle-power. The light is of such intensity that a person is enabled to read fine print at a distance of 100 to 150 ft. The inventor claims that the cost of his incandescent light of 1,500 candle-power is only 4½ cents per hour, while that of the ordinary electric light of 400 candle-power is (in Germany) 14 cents per hour. In the apparatus constructed by Salzenberg a hydraulic pressure of 3.5 atmospheres, and even more, may be forced through the improved Auer burner. The invention is, however, only applicable where water-works exist.

We are informed that the "Grand Prix" or highest possible distinction for machine tools at the Brussels Exposition has been awarded to Messrs. Brown & Sharpe Manufacturing Company, to the Pratt & Whitney Company and to one Brussels firm. Messrs. Gould & Eberhardt received a gold medal, which was next to the highest distinction, and a silver medal was awarded to the Acme Manufacturing Company, of Cleveland, O.

The Russian Locomotive Construction Company has, according to a cable dispatch to the New York *Sun*, been authorized by the government to place orders for 400 engines abroad.

The Baltimore & Ohio Annual Report.

The 71st annual report of the Baltimore & Ohio Railroad Company, submitted Nov. 15, at the meeting of the stockholders, shows gross earnings for the year ending June 30, 1897, of $25,582,122.31, an increase of $1,637,310.71 over the previous year, and $2,761,940.07 more than in 1895. The freight earnings were $18,336,851.87, an increase of $1,518,180.03, which increase is ascribed to the many improvements and large increase in equipment afforded the patrons of the line by the Receivers and to a general and intelligent effort to increase the traffic of the road. The passenger revenue was $5,059,001.92, a decrease of $256,911.47, or $9,701.65. more than was earned in 1895. The miscellaneous earnings increased $378,719.15, of which increase the elevators contributed $326,779.38, they having earned $514,125.11 in 1897 as against $187,355.73 in 1896.

The total expenses of the line were $20,012,093.81, an increase of $2,428,673.46. This increase is explained by the statement of the large sums required in maintenance of way and maintenance of equipment, which went into the property for the purpose of improving its earning capacity such as putting all of the engines and cars into good condition. Considerable work has been done at Locust Point to improve the facilities for unloading ships. The report of the General Manager shows that the tonnage carried, including coal and coke, was 18,716,665, an increase of 854,728 tons, or 4.8 per cent. The tons carried one mile increased 666,903,303, an increase of 23.4 per cent. During the year nine locomotives were rebuilt, 445 received thorough repairs, 1,339 ordinary repairs were were made, 211,012 running repairs made. The total cars in service June 30, 1897, were 672 passenger and 30,980 freight. The locomotives number 863. The car mileage increased 55,540,468. The total number of passengers carried in 1897 was 8,344,073, a decrease of 223,116.

The Effect of Brakebeam Hanging Upon Brake Efficiency.*

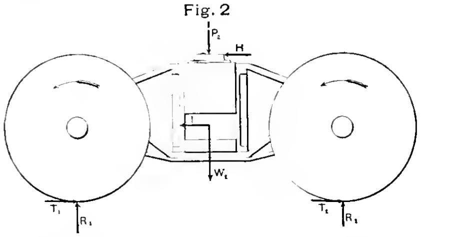
BY R. A. PARKE.

Surrounded as it is by dynamical conditions which are in themselves very complicated, and which are only partially understood, it is not surprising that a systematic analysis of the design and action of brake gear has been neglected; but the complexities are not too great to permit a sufficiently satisfactory analysis to be made, and the prospective benefits to be derived from the information thereby obtained appear to reward the tiresome work which such an analysis has involved. That such an analysis has afforded the clue to such a simple modification of the present mode of suspending brakebeams as will enable trains to be stopped thereby in from 10 to 15 per cent. shorter distance, sufficiently attests the value of attacking dynamical problems through the methods of theoretical mechanics.

It should be plain that what actually retards the motion of the car is the frictional resistance of the rail upon each wheel, which is initiated whenever any force acts upon the wheels to cause them to lag in their continued rotation. It is to be remembered also that the persistent rotation is only of such degree as is necessary at any time to overcome the resistance to the rotation of the wheel.

The tendency of the frictional resistance applied by the rails to the wheels, when the brakes are applied, is to overturn the car

Fig. 2



body about an axis of rotation which is situated at the center plate upon the forward truck, and also to overturn each truck about an axle of rotation situated at the point of contact between the forward pair of wheels and the rails.

All the retarding forces are applied to the car body at a point considerably below its center of gravity. The resultant of this system of retarding forces is an eccentric force resisting the forward motion of the car body. It therefore tends both to cause a retardation of the motion of the car body and to cause the car body to rotate about the forward center plate. The result is that the portion of weight carried upon the rear truck is diminished, and there is a corresponding increase in the weight carried upon the forward truck.

Such being the fact, it is unquestionable that a less pressure of the brakeshoes must be exerted upon the wheels of the rear truck than could be exerted upon the corresponding wheels of the forward truck, to prevent wheel sliding at the rear truck. The greatest brakeshoe pressure which can be applied to the wheels, without causing them to slide upon the rails, is thus limited by the pressure of the wheels of the rear truck upon the rails, and no further consideration whatsoever need be given to the forward truck.

Fig. 2 represents the rear truck of the car under consideration. Here it will be seen that the forces T_1 and T_2, resisting the forward motion of the truck, are applied at the lowermost points of the structure, while the forces urging the truck forward are, first, the force I, due to inertia, applied at the center of gravity of the truck, and, second, the force H, applied at the center plate, far above the center of gravity. This condition inevitably results in a reduction of the normal pressure of the rear pair of wheels upon the rails, and in a corresponding increase in the pressure of the forward pair of wheels upon the rails.

We finally reach the primary object of this discussion, which, briefly stated, is a realization of the facts that, during any application of the brakes, the rear truck carries the least weight, and in any case where the brakebeams are suspended from the truck, the rear pair of wheels of the rear truck exerts a less pressure upon the rails than any other pair of wheels upon the car.

If this fact is now clearly understood, it will be equally clear that, in order to prevent wheel sliding, a uniform brakeshoe pressure upon each pair of wheels must be limited to what is safe upon the rear pair of wheels of the rear truck.

In a communication to the *Railroad Gazette* of Oct. 24, 1890, it was pointed out that a variation in the angle at which the brakebeam hanger inclines to the tangent to the wheel at the center of the brakeshoe results in a variation in the pressure of the brakeshoes upon the wheels. The principal purpose of that investigation was to call attention to the fact that inefficiency, on the one hand, and wheel sliding, on the other hand, might thus be accounted for in cases where other reasons appear to be absent. It was also there pointed out that, in order to obtain a uniform pressure of the brakeshoes upon each pair of wheels, the brakebeam hangers must be practically parallel to the tangent drawn to the wheel at the center of the brakeshoe.

A careful investigation has revealed the fact that, by a proper inclination of the brakebeam hangers, the brakeshoe pressure upon each pair of wheels may be fairly proportioned to the pressure of that pair of wheels upon the rails. The utilization of this principle will now be considered.

Fig. 3

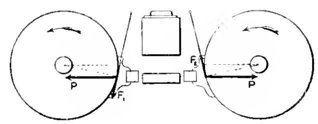
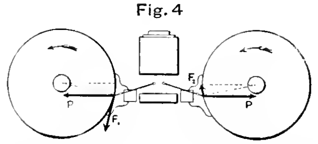


Fig. 4



It is manifest that the rear pair of wheels, when the car is moving in one direction, becomes the forward pair of wheels when the car is moving in the other direction. It is, therefore, absolutely essential that any successful method employed for increasing the brakeshoe pressure upon a pair of wheels, when the car is moving in one direction, must decrease the brakeshoe pressure upon that pair of wheels when the car is moving in the other direction. This is precisely what results from a proper inclination of the brakebeam hangers.

Fig. 3 represents the action of the brakes upon each pair of wheels of a truck when the brake hangers have the direction of the tangent to the wheel at the center of the brakeshoe. The same pull P is applied to each brakebeam. The brakeshoes apply a downward frictional force F_1 to the forward pair of wheels and an upward frictional force F_2 to the rear pair of wheels. The center of the brakeshoe is shown to be at the intersection of these forces upon each pair of wheels, and lines representing the brake hangers are drawn tangent to the wheels at those points. It must be observed that, with whatever force F_1 the brakeshoes act downwardly upon the surface of the forward pair of wheels, the wheels react upwardly upon the brakeshoes, and this upward force is directly resisted by the brake hangers. There is thus a direct compression in the forward brake hangers equal to the frictional force F_1. In a similar manner it will readily be understood that the rear brake hangers are subjected to a tension which is equal to the frictional fore F_2.

Let us now consider an exaggerated case of inclination of the brake hangers, such as is shown in Fig. 4. Each brakebeam is here subjected to the same pull P as in Fig. 3; but the fractional forces of the brakeshoes upon the two pairs of wheels are no longer equal, as they were in Fig. 3. When the brakeshoes have been brought into contact with the forward pair of wheels, the combination is something similar to a toggle-joint. The reacting upward friction of the wheels upon the brakeshoes tends to carry the brakeshoes upwardly, along with the surface of the wheels, and on account of the nearly horizontal position of the hangers, there is a strong tendency to force the forward pair of the wheels away from the center of the truck. This tendency is, of course, resisted by the truck frame, and thereby a powerful pressure occurs between the brakeshoes and the wheels, in addition to the pressure resulting from the pull P upon the brakebeam. In this way, the brakeshoe friction F_1, upon the forward pair of wheels of Fig. 4 is materially greater than is the case in Fig. 3. where the angle of the hanger is such

* From a paper presented at the November meeting of the New York Railroad Club.

that it exerts no influence to force the brakeshoes against the wheels.

The effect of the inclination of the hangers upon the friction of the rear pair of wheels of Fig. 4 is precisely the reverse of what it is in the case of the forward pair of wheels.

It is thus seen that if the brake hangers are so adjusted that they have the same angular direction as the tangent drawn to the wheel at the center of the brakeshoe, as in Fig. 3, the frictional resistance offered by the brakeshoes to the rotation of the wheels will be the same upon each pair of wheels. If, however, the brake hangers be sufficiently inclined to the tangent at the center of the brakeshoe, the frictional resistance of the brakeshoes to the rotation of the forward pair of wheels will be increased, while the resistance to the rotation of the rear wheels will be merely nominal.

It will be observed that, if, in Fig. 4, the wheels rotate in the opposite direction, through motion of the car in the opposite direction, what has been considered the rear pair of wheels will now become the forward pair. At the same time, also, the effect of the inclined hangers upon the two pairs of wheels has been reversed, so that it is still, under the changed conditions, the leading pair of wheels which is subjected to the greatest breakshoe pressure, and the rear pair of wheels which is sthjected the reduced pressure. Here, then, is a method of utmost simplicity whirh fulfills the requirements of the case.

Fig. 9

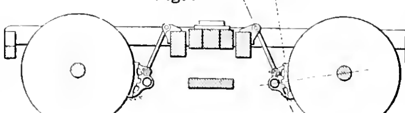
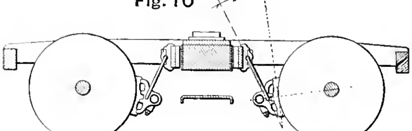


Fig. 10



A most important feature of this method will, doubtless, not have escaped observation. This feature consists of the fact that the conditions prevailing in Fig. 4 are those for brakes which are hung between the wheels. As a foremost consideration it is necessary, in order to realize the advantage of the principle of inclined brake hangers, that the brakes shall be inside hung. It has been the practically universal custom to suspend the brakebeams of passenger trucks outside of the wheels. This is radically wrong if proper efficiency of the brakes is desired. The most important advantage [of inside hanging] is that the brakeshoe pressure upon the different pairs of wheels may be so proportioned that in an emergency application of the brakes trains may be stopped in from 10 to 15 per cent. shorter distance without any increased liability of injurious wheel sliding. This advantage is, of itself, so important as to overshadow all objections.

Another important advantage is the smoothness with which passenger train stops may be made. The tilting action of the ordinary passenger truck, during an application of the brakes, and the resulting jolt at the stop, has commonly been observed.

Still another most excellent feature of inclining the brake hangers is the fact that the weight of the brakebeams and attached parts thereby tends to swing the brakeshoes away from the wheels after release of the brakes.

The inside hung brake gear for passenger trucks is not only more compact and simple, but it is less costly in construction and maintenance. It enables brakeshoe slack to be taken up more evenly and completely. It enables the proper braking power—and thus the full efficiency of the brakes—to be calculated with greater certainty. In connecting and disconnecting the brake gear upon the truck there is no resistance of release springs to be overcome, and the removal and replacement of brakeshoes is thereby facilitated.

Brake gear.	Wheels.	Inclination of hanger to tangent.	Braking power, in percentage of weight.	Total brakeshoe friction in percentage of weight.
Freight, inside from truck......	33-in. cast iron.	34° 53′	95.2	24.8
Passenger, inside from truck.......	36-in. steel tired	32° 26′	110.4	25.2
Passenger, inside from truck........	33 in. cast iron.	28° 2′	91.7	25
Freight, outside from car....... ..	33-in. cast iron.	25° 49′	80.7	22.8

It will be interesting to now compare the braking force and the retarding friction of the brakeshoes under the various conditions heretofore existing in practical service. The figures given in the tables are those computed by the methods given in the appendix, and the braking power and total brakeshoe friction given are those which will produce the same tendency to slide wheels in each case. The braking power given is computed to the highest which, under normal conditions of air pressure and brake cylinder piston travel, will result in no harmful sliding of wheels, under the average condition of service.

Brake gear.	Size and kind of wheels.	Braking power in percentage of weight.	Total brakeshoe friction in percentage of weight.
Freight, inside, truck frame.	33-inch cast iron.	68.8	19.7
Passenger, outside, truck frame	36-inch steel tired.	88.	20.8
Passenger, outside, truck frame.........	33-inch cast iron.	76.5	20.8
Freight, outside, car body...	33 inch cast iron.	70.4	20.4

It will be observed that in freight service a somewhat greater braking power may be employed, causing a slightly greater retarding friction when the brakebeams are hung from the car body. This is because less weight is transferred from one pair of wheels of the truck to the other pair than when the brakes are inside hung. When the brake hangers are inclined, however, this form of brake gear is notably inferior, as shown by the following table of maximum inclinations:

The surprising effect of the angularity of the brake hangers, in permitting a greatly increased braking power without increasing the danger of sliding wheels, will be at once recognized by comparing the figures in this table with those in that last preceding. The real value of the inclination of the brake hangers is, however, to be discovered by comparing the retarding frictions of the brakeshoes upon the wheels. The efficiency of the brakes has been increased from 20 to 25 per cent. in each case, except that in which the brakes are hung from the car body, where the increased efficiency is only about 12 per cent.

Fig. 9 illustrates the application of inside brakes with inclined hangers to a Canadian Pacific passenger truck. In this case, the angle of inclination, when shoes and wheels are new, is 15 degrees 49 minutes, and the length of the brake hanger is 18 inches, the form of brakehead shown being necessary on account of the position of the equalizer spring seat. The calculated braking force is about 95 per cent. of the weight of the car, and the total maximum friction of the brakeshoes in an emergency application is about 22.9 per cent. of the weight of the car. The stopping efficiency is theoretically about 10 per cent. greater than if the brakes had been hung in the ordinary way. A train of Canadian Pacific cars, with this truck brake equipment, was tested upon the main line of the road near Montreal. The day was a fair one and the rails in average condition. The stops were made with the high-braking power upon a portion of the cars, and a braking power of 90 per cent. upon others. The wheels of the cars with high braking power slid during the last 10 or 15 feet of each emergency stop, and the wheels of the cars having the 90 per cent. braking power slid through about half this distance. Fearing that the brakeshoes were not yet properly fitted to the wheels to make highly efficient stops, it was requested in advance that no speed recorder be applied to the locomotive, and that no attempt be made at that time to determine the stopping efficiency of the brakes. All present were so much impressed, however, with the unusual effectiveness of the brakes, that one or two stops were made from estimated speeds, and the distance measured. Making ample allowance for errors in judgment as to speed, the stops made appeared to be about 15 per cent. shorter than any recorded passenger train stops from similar speeds.

Fig. 11

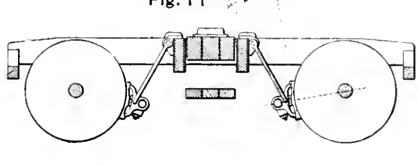


Fig. 10 illustrates the application of inside hung brakes to the standard passenger truck of the Pennsylvania Railroad, the angle of the hanger being 19 degrees 53 minutes when the shoe and 36-inch chilled iron wheel are new. The calculated braking power is about 86 per cent. of the weight of the car, and the total maximum brakeshoe friction in an emergency application of the brakes is 23.3 per cent. of the weight of the car. The stopping efficiency of this brake gear is about 13 per cent. greater than if the brakes were applied in the ordinary way.

Fig. 11 illustrates the standard passenger truck of the Erie Railroad. The length of the brake hanger is 24 inches, and the angle of inclination is 20 degrees 21 minutes when the brakeshoes and 36-inch steel-tired wheels are new. The braking power is about 97 per cent. of the weight of the car, and the total maximum friction of the brakeshoes is 23.2 per cent. of the weight of the car. The increased stopping efficiency of this brake gear is about 13 per cent. greater than would be the case if the brakes were hung in the ordinary manner.

The Commerce of the Great Lakes.*

BY CHARLES E. WHEELER.

The disastrous panic of 1893 was not without its benefits. It not only revealed the necessity of a reform in our monetary system, a lesson as yet blindly unheeded by the nation, but taught as well the need of industrial economics, and along this line most commendable progress has been made. During the past three years every manufacturer's office has been a schoolroom, whose instructor has been Necessity, and the lesson that of applied economics and cheaper production. Mr. Carnegie, for instance, was an apt student and learned the lesson quickly. He built a railroad from the south shore of Lake Erie to his furnaces on the Monongahela and cut the rail-carrying charge in two. He went beyond that; availing himself of the dilemma of Mr. Rockefeller, possessed accidentally of several large deposits of ore on the south shore of Lake Superior, he was able to place himself in a position as regards ore supply to compete with the world, at the same time lowering the transit cost of the ore from the mine to his railroad. Mr. Rockefeller in turn saw meagre profits, unless, availing himself of the deeper channels furnished in recent years by the government, he had larger boats to carry his ores than have been running in the trade. He built a dozen of them, and thus it happened that more than half of all the steel tonnage in the merchant marine of the United States built in 1896 was the product of our lake shipyards, and surely our pride in that we now own more than half of the merchant marine of the United States as regards boats of 1,000 tons burthen and over is quite pardonable.

Everywhere, less noticeable because on a lesser scale, the same trend towards the same end is to be found. It has not received the attention it deserves—the constant, determined, intelligent effort of the American manufacturer, during the years of financial trial, to open new markets, stop wasteful expenditures, cheapen production. With returning prosperity, he is rash who will set limitations on American trade abroad or at home, a result of the discipline of 1893, '94, '95. The growth of our export trade in the iron list is unmistakably genuine, recognized and frankly acknowledged by English competitors. The Duke of Devonshire, at the meeting of the Barrow Company Directors, spoke of it as "alarming." The *London Times*, commenting on his declaration, marvels at the magnificent scale of operations at Homestead, where it finds furnaces each producing 200,000 tons of pig iron per annum the average capacity of the English furnaces being less than 24,000 tons per annum. During the last month or two rails for Liverpool have been coming to tidewater all rail from the Cleveland District. Nails and iron rods have been going abroad in generous quantities. The future is full of hope if unwise legislation do not create more artificial barriers than the ingenuity of the American manufacturer can overcome.

Contributing to this happy condition of affairs, the cheap transportation on the lakes has been a factor of prime importance. The transporting interests on the inland waters have not failed to meet the new situation with intelligent effort and splendid courage. It was inevitable that cheaper transportation should come. The 20-foot channel from Duluth to Buffalo is practically completed, and the invitation to larger boats and cheaper rates could not be denied. Besides, the traffic itself is of such magnitude as to compel a minimum rate. Over that course of commerce must come the nation's breadstuffs, its lumber, its iron and copper ores, in quantities that pass comprehension. The figures for 1897 are, of course, not yet complete, but there is little doubt, if any, that the most prosperous year will be equalled, even surpassed. If this proves true, over 58,000,000 tons of freight will have passed through the Detroit River in 1897. Load that freight in cars, 20 tons to the car, place the locomotive at New York and the caboose will be in New York as well, but between the two nearly 2,000,000 cars will be found, extending across the continent to San Francisco, back again to New York, again across the continent, again back to New York. It is a greater commerce than that of Liverpool or London, foreign and coastwise, greater than both combined. It exceeds the total entries and clearances in the foreign trade at New York, exceeds the total of like entries and clearances at all the seaports of the United States. I am speaking of quantities, of course, not values.

Imagine, if you can, the uses to which the freight is put, the industries it nourishes. Sixty-six per cent. of all the ores used in the United States comes through the Sault, and, notwithstanding the bright outlook and flattering showing made by the Alabama and Tennessee districts, the percentage of the total amount of ores used is not only markedly in favor of the Superior ores, but the percentage increases year by year.

Two-thirds, then, of all the ores used in this country come from the south shore of Lake Superior and are the sole source of supply of such mills as those of the Carnegie Company, the Illinois Steel Company, the Johnson Company, the Cleveland Rolling Mill Company, and others that are now confessedly equipped to compete for foreign trade. If our hope in the future supremacy of the American iron and steel maker is well grounded, surely we may look for its justification in the furnaces between Cleveland and Pittsburg. There, if anywhere, must be found the means by which, in an iron age, this country may assume a commanding position in the iron markets of the world.

And the whole matter depends on cheap transportation. Remove the chain of lakes and no railroad or system of railroads could hope for a moment to place the 140 different iron and steel manufacturers in the Central States district in a position to compete with foreign mills, and in the catastrophe thousands of allied industries must inevitably be abandoned. For the coal, for the coke, is in western Pennsylvania and the ores over 900 miles away. No railroad in America is better equipped to transport freight cheaply than the Lake Shore & Michigan Southern. Its grades are light, its tracks and roadbed unsurpassed. The cost per ton-mile in 1896 on that railroad was 3.81 mills; the cost on the lakes .99 mills. We have this year reduced the latter figure fully one-third in the operation of the larger boats. We have been bringing ore from the south shore of Lake Superior to Cleveland at a rate of but 15 cents per ton over the ordinary railroad switching charge in any of our large cities. We have been taking coal back at one-third the New York lighterage rate.

To reach such results has demanded the most rigid regard for economies in every direction. It has worked a revolution in loading and unloading cargoes. It became necessary that appliances should be such that 6,000 tons of ore could be loaded in a boat, the boat trimmed and ready to depart for her Eastern terminus within four hours after tying up to the dock. It became necessary that at this end of the line those 6,000 tons should be unloaded in 10 hours. It became necessary that 40 cars an hour, each car containing 25 tons of coal, should be lifted up bodily one at a time, and the contents discharged into the boat as easily as a laborer flips his shovel.

When Mr. Carnegie amazed the world last spring with his low quotations and other mills followed, let it not be forgotten that it had been impossible but for our ship yards, the genius of the mechanical engineer, and our steamship organizations, which have availed themselves of every known appliance for the economical conduct of their business. Had it not been for them and the lakes, Mr. Carnegie had sought in vain for his foreign market, Mr. Moxham had returned from Liverpool empty-handed, and the Cleveland rod and nail mills had never dreamed of Japan and England for profitable sales. The commercial supremacy of America in iron and steel manufacture is impossible but for the great lakes.

And now let it not be thought that the greater part of that traffic is the carrying of iron ores. It is nearly half of the tonnage, it is true, but in value occupies but fourth position. The total value of freight passing through St. Mary's Falls Canals in 1896 was over $195,000,000. Of this amount wheat must be credited over $47,000,000; flour, $31,000,000; unclassified freight, $31,000,000. Iron ore, with $25,000,000, comes next, closely pushed by copper with $23,000,000 to its credit. If the grain shipments out of Chicago and the lumber shipments from Lake Huron be added, and again there be added the value of the coal and merchandise shipments from Lake Erie to Detroit and Lake Michigan ports, the importance of iron ore in the list is not so readily recognized, and it will be seen that what I have said of the lakes and its relation to the iron industry applies quite as well to wheat, corn, oats, flour, and possibly copper.

It is almost certain that the indirect effects of lake transportation are of greater importance than the direct. Mr. Blanchard, in his argument of March, 1894, before the committee of the United States Senate on interstate commerce, made a significant and, as I believe, absolutely truthful statement in these words: "I contend," he said, "that after rivers, lakes, oceans and economic forces have spent their combined natural and national powers in determining rates which are reasonable, such rates cannot be made excessive by combination." Mr. Blanchard was defending railroad pools, a question alive to-day and destined to command careful public consideration in the years to come. As a representative of the railroad interests, his plea may be that of an advocate, yet the fact is he was entirely correct. No railroad or combination of railroads can disassociate itself from the traffic means we are considering. It is a controlling factor, and if Duluth can ship her flour from that port to Liverpool for $14\frac{1}{2}$ cents per hundred—a privilege she enjoyed for a brief time the past summer—its effect is instant upon every railroad that has flour mills to protect or grain to haul to them. And then, too, it is not iron ore, flour and wheat that alone monopolize the low rate. The class freight annually carried over the lakes between the great commercial centers, Chicago, Milwaukee, Detroit, Toledo, Cleveland and Buffalo, and beyond in connection with the rail lines and the Erie Canal, is an item concerning which, unfortunately, no accurate data are at hand, thanks to a law which does not exact reports of any considerable statistical value; but the fact that all your trunk lines whose western terminus is Buffalo own and operate their own boats, and the fact before cited that the unclassified freight in the Lake Superior trade amounts in value to over $30,000,000 per year, hint at the enormous value of the total class business transacted in the lake trade. None of the trunk lines may ignore it and its influence is far felt. If it became a traffic necessity for the Lake Shore & Michigan Central and the New York Central & Hudson River railroads to approximate the lake and rail or lake and canal rate on any commodity from Chicago to New York, be sure the other trunk lines will meet it, and give their tidewater terminals the same rate, not omitting the differentials. As was the case this summer, even the north and south lines, such as the Illinois Central, must, of necessity, take a hand, protecting their gulf termini against the competition thus forced on them. Now, while its effects are of little consequence, perhaps, in regard to higher class freight, there can be no question but all the 6,000 railroad stations east of the Mississippi and north of the Ohio River reap a decided benefit in the carrying cost of the lower class freight and commodities; for when through rail rates are reduced between Chicago and New York, for instance, because of lake competition, they are simultaneously reduced between intermediate points because of the long and short haul clause of the interstate commerce act. The effect is widespread, often disastrous to the carrier, but at least yields this comfort—that the present unmistakable tendency toward concentration of railroad interests, or the enactment by Congress of a law permitting railroads to pool, is a menace of academic rather than real interest. So long as our water highways are open, the railroads have a competition that cannot be overcome.

There is another reason why this competition is irresistible. In the building of boats and their machinery, the naval architect and marine engineer may hope reasonably to keep in advance of the

* From a paper read before the Society of Naval Architects and Marine Engineers, Nov. 11, 1897.

maintenance of way engineer, the master car-builder, and the superintendent of motive power. Walking through the Globe shipyards one day with Mr. Parkhurst, he picked up a piece of coal the size of a walnut and remarked: "You would hardly think that little lump of coal will carry a ton of freight a mile, would you? and yet that is what it will do on our better class of boats." It is true; fifty-five hundredths of an ounce of coal per ton-mile is the record.

Now, such results are not to be expected in the performance of a locomotive; at least they are not in sight. Such economies are associated with triple and quadruple expansion engines, and it is worthy of note that for the first time in the history of shipbuilding in America we on the lakes are now building our freighters with quadruple expansion engines. Then, too, our waterways are being deepened, our boats being enlarged. Until last year they were less than 400 feet long. We are now building them 475 and 500 feet in length over all.

There is in a workshop at Cleveland an internal combustion engine built for the company with which I am associated. It weighs about two tons, and is, if I mistake not, the first compound gas-engine that successfully meets all requirements. Its cards show an indicated horse-power of 114, and a thermal efficiency of 39.5. Making no claim whatever to a technical mechanical training, I am perhaps treading on dangerous ground, but this at least is known—that, reduced to steel strains, we have an engine of 92 horse power per ton, a record far surpassing that of the Turbinia, an engine that exhausts at atmosphere and that may be built to any power, if some of your own brightest marine engineers are not in error. In any event, it is certain that the principal of a compound gas or oil engine is now thoroughly understood, and whether the present device fulfills expectations or not, assuredly the time is not far distant when important results will come from the untiring efforts of mechanical engineers to transfer the source of power from the boiler to the cylinder. I mention it because indicative of a possible revolution in mechanics that will work economies in the engine-room of a vessel impossible to the locomotive, and thus increase the already marked difference between the cost per ton mile by water and that by rail.

Clearly we have not yet sounded the possibilities of cheap transportation by water, and with their discovery one may be justified in believing that their application can nowhere be productive of more beneficent results to mankind than on those waters to which are annually consigned the products of the vast plains of the West, the nation's food and the supply of her workers in iron.

Painting by Compressed Air.*

BY H. G. MAC MASTERS.

We presume that a paper on painting railway equipment with compressed air, based on every-day practice, strictly adhering to facts instead of citing what has been done or what can be done, will best serve the purpose.

After a few trials with the machine we felt perfectly satisfied that it would spray paints, be they light or heavy, the only question now being would they dry, look as well, and, above all, wear as well as paint applied with a brush? Of the first two we have satisfied ourselves that, by changing formulas somewhat for some makes of paints only, paint will dry, look as well, and, with some colors, look even better than brush work, and, as for the wearing qualities, we can only say that we have recently seen some work that has been out nearly a year, and that it looks quite as well as brush work.

However, our faith is and has been so great in the machine that every freight car, whether box, stock, coal, fruit or refrigerator, that we have painted since last November (excepting a few that were too far from air connections) have been done with it, and we are satisfied that with this method of painting we need have no fear for the wearing qualities of paint.

We made a great many tests of different makes of paints, and found the machine would spray any of them, there being no difference so far as the machine was concerned, but it was in the looks and drying qualities that we found the difference, the common faults being those of drying flat in spots, and skin or surface drying; but this was overcome in most cases by the addition of a certain per cent. of japan oil—what per cent. can best be determined by a little experimenting, although we find one-third japan oil and one third boiled linseed oil answers as a reducer in most cases.

Several paint concerns are now making special spraying paints that are giving very good satisfaction, particularly on old woodwork. Paint for the spraying machine should be one that dries from the bottom out, and not from the surface in.

We also made a test to determine the weights of all kinds of paints best suited for the machine, and have concluded that we should use the same judgment with the machine that we would were we going to apply the paint with the brush—for instance, if you are going to prime a car, use paint of the same consistency as you would if you were priming it with the brush, and so on with succeeding coats. If you have an old car that you only wish to give one coat, of course make it heavy.

After we got to painting freight cars in good shape, it was said that it might do for common freight cars, but it would never do for passenger cars. This may be true, so far as the body of the car is concerned, but we have proven very conclusively that it is not so with trucks.

The old method of doing trucks was to give them one coat of color and one coat of varnish, no striping. We tried the spray on them with flat or turpentine color, and then with a light varnish color, and kept increasing the varnish until they looked so well that we concluded to discontinue the coat of varnish, and now only give them one coat. We are not only doing this on an occasional truck, but on every one, thereby saving 37½ cents on every pair of trucks over the cost of application of this varnish color by brush, as well as the cost of a coat of varnish. And still it is claimed by some it does not pay.

It has been said that if you have only one car a day to paint it does not pay to use the machine. We take it for granted, of course, that the shops are conveniently piped for air. If you can fill your machine, attach your hose, spray your car, put away the hose and clean the machine, and you have accomplished in 30 or 40 minutes what it would otherwise have taken two or three hours to do, it surely would pay. This is done nearly every day.

Some time ago we had 12 baggage car letter cases sent to the paint shop to be primed; we had a man prime one by hand, it taking him 14 minutes; then we had him spray one, which took seven minutes. It is needless to say the rest of them were sprayed, saving about 1 hour and 10 minutes. We thought that paid us.

The saving in brushes is an item well worth considering. A well-known railroad man made the remark some time ago that air painting was a fad, and would soon die out. Well, if a saving of $800 or $1,200 a year is a fad, it would be well for the railroads to have more faddists.

We are at present building at Burnside shops 120 new 35-foot box cars, which we are painting with the spray at a cost for labor, complete, excepting lettering, of 57¾ cents.

We painted one of these cars by hand at a cost for labor, excepting lettering of $1.63¾, using 7½ pounds of paint more than on the car sprayed.

Below is a table of comparative cost of labor painting cars by hand and with the spray, also one of passenger trucks:

COMPARATIVE COST OF LABOR, PAINTING ONE NEW 35-FOOT BOX CAR.

	With the Brush.			With the Spray.		
	Time.	Rate.	Cost.	Time	Rate.	Cost.
Sills, 1 coat......	20 minutes	15 cents	$0.05	13 minutes	15 cents	.03¼
Edge roof boards, 1 coat..........	40 "	"	.10	17 "	"	.04¼
Body, 3 coats....	7 hours	"	1.05	1 h. 24 min.	"	.21
Putty	1 hour	"	.15	1 hour	"	.15
Roof, 2 coats.....	30 minutes	"	.07½	12 minutes	"	.03
Trucks, 1 coat....	1 hour	"	.15	20 "	"	.05
Blacking off irons, etc	25 minutes	"	.06¼	25 "	"	.06¼
Total cost......	....	......	1.63¾	....	......	.57¾

Total saving $1.06, or 64 73/100 per cent.

ONE SET OF PASSENGER TRUCKS.

	With the Brush.			With the Spray.		
	Time.	Rate.	Cost.	Time.	Rate	Cost.
Trucks, 1 coat...	3 hours	15 cents	.45	½ hour.	15 cents	.07½
Total cost......	....	......	.45	....	......	.07½

Total saving, $0.37½, or 83⅓ per cent.

The above cost of painting trucks does not include sandpapering or puttying; simply the application of paint.

The saving in painting of all the freight cars is proportionately the same. Now, about the mist or fumes from air painting: this seems to be the worst or hardest feature to overcome.

We compel the operator of the machine, if working in the shop, against his will to wear a sponge over his mouth and nose, if he has more than one car to spray.

While spraying the passenger car trucks he does not use a sponge. The fumes from varnish color are less than from an oil or turpentine color.

The machine can be used to good advantage on locomotives, bridges, buildings and any number of other things that require painting where you can get air, but, having had very little practical experience in these, we leave them for others who have to write about.

* From a paper read before the Car and Locomotive Painters' Association.

EQUIPMENT AND MANUFACTURING NOTES.

The Richmond Locomotive Works have contracts for the special parts for converting five Class T Norfolk & Western engines to the Richmond compound type. They will also build two locomotives for the Richmond, Fredericksburg & Potomac.

At a special meeting Mr. Robert T. Lincoln was elected a Director of Pullman's Palace Car Company to succeed Mr. George M. Pullman and he was also elected Chairman of the Executive Committee which is to take charge of the affairs of the company. He will be Acting President.

The Chicago, Milwaukee & St. Paul is building a new passenger station in Minneapolis, on the site of the old one.